# THE ACHIEVEMENT OF MAN

BY

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# PREFACE

I INTEND this book to be a simple introduction to the progress of modern science in relation to our daily lives. I have not attempted to present any abstruse or technical aspects of the various sciences even in a popular or generalised form; but merely to indicate the direction in which the sciences are progressing and adding to man's knowledge and mastery of his environment. My purpose will be fully realised if the reader's curiosity is aroused, and he is led to gather such comprehensive information, on the topics that interest him, as is not available in the following pages.

Exception will, perhaps, be taken by advanced students of the subject of this book to certain statements that are not universally true, but are made as if they were. I have referred to the crowning glories of human effort, regardless of the country and clime where it has been made. Howsoever the prevailing political conditions of the world may belie the fact, it is undeniable that to a scientist all humanity is one. Besides, it is not extravagant optimism to discern that the march of human civilization is more and more in the direction of levelling down the barriers that have divided the so-called backward communities from their more fortunate brethren in the world.

Therefore, in my opinion, this book may be of some especial use to Indian readers; for here the achievement of man is not generally so well-known as it should be.

M. G. S.

*Postscript*

This book was written in 1929, and underwent careful revision before being sent to the Printers. But

so rapid is the advance of human endeavour, and so momentous the times through which we are passing, that some of the facts given to illustrate the Achievement of Man have already been surpassed. The young and intelligent reader who is undoubtedly keeping himself up to date in speed records and the like will check off my anachronisms.

# INTRODUCTION

HUMAN activity has within historic times been concerned mainly with two very distinct types of achievement. Man's theoretic faculty engaged in speculation has acquired for his kind an invaluable heritage of philosophy, science, and the fine arts. His practical sense, after centuries of persistent endeavour, has now given him a more or less sure command of his environment. The distinction between these two important phases of human activity is by no means so clear as our statement makes it out to be; but it was not till recent times that their interdependence was realised, or the influence of one on the other began to be exerted.

The ancient philosophers looked with ascetic disdain on all those 'grosser' arts which made the daily lives of their fellowmen pleasant and comfortable. They exalted to the position of 'liberal' knowledge only those branches of human learning from which no material gain was likely to accrue. They looked down upon such mechanical aids to reflection as observation, experiment or the like. The best of human philosophy was deduced as a process of introspection; and the best of human sciences progressed by laws of close reasoning from premises taken for granted without any valid proof or evidence other than that of traditional authority.

As late as the seventeenth century in Europe, and almost till the other day in Asia, it was the practice

of 'wise' men who had the political power in their hands to put down ruthlessly all attempts at independent thinking based on the unimpeachable evidence of the senses. As late as the earlier years of Queen Victoria scientific thought in the modern sense was not possible except to a handful of men.

It is to the credit of modern science to have established once and for all the freedom of human thought. Not only that, but also to have shown the unity of aim for the speculative thinker, and the practical artisan. The scientific philosopher of today welcomes the practical uses to which the fruit of his researches can be put for the amelioration of human misery and pain. He enjoys to the full all that sense of confident supremacy over the varying conditions of life on this earth which the 'material' civilization of the twentieth century assures him and the rest of mankind. And yet he refuses to be sidetracked by these material gains: with the same high ideals and devotion that distinguished the ancient philosophers, he engages in the pursuit of truth, for the sake of truth. The paths and methods of his pursuit are albeit very different.

It is sometimes supposed, particularly in the East, that the glory of modern achievements rests on a series of wonderful inventions which physical science has made possible. It is not as widely known, or realised, that the man of science today is not the inventor-genius of popular imagination. He is as keen a 'philosopher' as any metaphysician of ancient Greece, or Hindustan. Particularly the modern

physicist, and equally so the modern bio-chemist, indulges in speculation which in its abstruseness and difficulty surpasses the subtle hairsplitting logic of the ancients. But with one very radical and vital difference : the scientist today bases all his conclusions on demonstrable fact; the ancient philosopher distrusted the evidence of his senses, and, therefore, only too often worked *in vacuo*.

It is quite possible that many readers of this book will be led to regard it as a mere inventory of some of the more outstanding inventions of recent times. This would mean a denial of that spirit of scientific enquiry which has made these inventions possible, and for the sake of which alone this book came to be written. What I wish to bring into prominent relief is the dominating passion of the scientific mind; its love of truth; its persistence of effort by which this truth is fearlessly sought, and equally fearlessly expressed, in the face of insuperable obstacles sometimes. Freedom from prejudice, and openness of mind are but the necessary preliminaries which make a student of science face reality, as it is discovered to be and not as it has been preconceived.

An impression still lingers in some quarters that the study of science, and a too rigid following of its methods induces in its students a lack of reverence for high and noble things, and a want of just appreciation for things of beauty. This belief in the 'ungodly' tendencies of science is a remnant of those early Victorian days of a fierce struggle between science and religion; when truth came sometimes to

be perilously obscured through excess of zeal, and ignorance, now on one side now on the other. Science fell into evil repute because it tried to substitute a critical examination of truth, celestial or mundane, for a too credulous acceptance of superstitious belief and established authority.

But today it would be nothing short of calumny to accuse a man of science of irreverence, or, insensibility to beauty, or even of materialism in the older sense of the term. No one, not perhaps even the most intuitive artist, is more aware of the mystery, the immensity, and the immeasurable beauty of a universe which the man of science hourly contemplates from one point of view or another.

And not only this. The man of science has invaluable guidance to give even to workers in other fields of human thought. The religious man contemplating the everlasting and invisible realities of life and the beyond; the artist immersed in the joys of a world that is but too keenly alive to him, and that he seeks to reproduce in the elusive technique of his art, dare not disregard the scientist's contribution to human knowledge, or the processes of his intellectual being. Science now so thoroughly pervades our lives that it is impossible to escape its influence, or to think in utter defiance of its well recognised truths.

It is, therefore, of the utmost importance in the education of the young—whatever be the tendencies of their individual genius, their so-called tastes and aptitudes—to introduce them early in their careers to a general knowledge of what science has achieved, and

what it stands for. And in doing so it would be misleading on the part of a teacher to emphasize the achievements of man howsoever wonderful they may be. What needs stressing, and perhaps reiteration, is the indomitable courage in the love of truth that has made these achievements at all possible.

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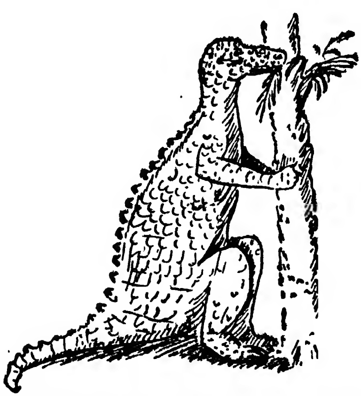
## CHAPTER I

### *The Dawn*

MORE centuries ago than you and I can count this earth of ours was a barren waste of waters. The green trees of which the poets sing were not there. The pretty songsters which charm us by their songs had not yet been born. In fact, *we* were not there: there was only an ugly uninviting mass of water, with here and there islands of mud and soft earth.

Centuries rolled by, and life began to creep on this earth. Thick ugly plants swam about in the pools of



AN EARLY MONSTER FEEDING OFF A TREE

water, tiny unknown creatures lived in the shelter and upon the food provided by them. Still there was no

man nor tree; no bird nor fish; nothing that we see about every day of our lives.

More centuries went past: for time in those old, old days is counted in ages and not in years. More centuries went past, and huge monsters peopled this earth. They lived in the water mostly. They fought and *bellowed*. They came on land which was beginning to dry up. There were trees now, but not the beautiful trees that give thick shade in the hot days of summer: short trees as ugly as the long-tailed, thick-skinned monsters that rubbed their long noses against them.

This went on for more years than we can count. One form of life came, and went. Some of these creatures survived, and others became extinct. Some of them like the whale and the elephant are still among us; they have survived in the struggle for existence. Others were not so fortunate; they have only left their bones behind them to tell us that they also lived and ruled on this earth at one time. Their bones lie buried under the earth. MAN the conqueror has survived to put these bones together, and re-make the creatures that are no more. But even he can have no idea of the shape, or form, or numbers of creatures that have come and gone leaving not a bone behind.

But whence came this conqueror, this lord of creation, this wonderful animal? Animals—even lions and leopards—slink away into the jungle at his approach. He has harnessed the forces of nature, and overcome its terrors. Night and lightning, thunder and earthquake, volcano and the storm at

sea terrify him no longer. Night comes and he turns it into day. He catches the lightning as it flies. Thunder and earthquake pass away leaving destruction behind. But he has energy and faith to build again. The only creature he is afraid of is himself—because he can do both good and evil.

It has taken him ages to attain to this position of dignity. Picture to yourself a world without houses, without roads, without even mud huts, fields, and wells. Nothing but swamps alive with monstrous crocodiles and other fearful animals, more like the dragons of romance, than like anything we know. There are everywhere dark thick forests with only the tracks of terrible monsters who broke their way through thickets feeding on the green leaves of high trees, or pursuing animals not quite as terrible as themselves.

Into this strange world first appeared man; not alone but in bands. He was then too afraid of everything to go about the world alone. His only safety was in numbers. He had no protection against heat and cold except the interior of a cave. He had no clothes, no weapons; but he had what no other animal has ever had—the capacity to think, and the capacity to speak out his thought. Reason and speech he has had from the very beginning, but not in their developed form as he has them today. How he came to have them at all is still an unsolved mystery.

From the very first man was a fighter. Man had to be a fighter, otherwise the world in which he lived was no cheerful place for him. As you have seen, it was a world in which animal preyed upon animal; a

world which was full of disease to which man alone of all the animals would fall an easy victim. But it was in this life of constant fear that the seeds of his greatness lay. The more he was afraid of his enemies, the more he thought out the means of escaping them.

It has been well said, 'the more you do, the more you can do'. The earliest men thought of combining together to beat their enemies back: we have from that tiny seed of union developed the big empires of the twentieth century. The earliest man made for himself a rude club of wood or stone to defend himself against an enemy whom nature had provided with sharp claws, and powerful arms: we have developed that rude club into the deadly weapons of modern warfare. The more man has tried to do the more he has achieved.

His achievement is not yet finished. Our life on this earth has been one long struggle against great difficulties. But there are more difficulties in front of us than there have been in the past.

You can easily imagine the difficulties that man had in the beginning. He had to learn things which seem simple to us. Take for example the use of fire. How would you like to live in a world in which people did not know how to make fire. You will have to eat uncooked food—remember there is no salt, pepper, or other spices in it; there is no bread to go with it. Then you will have to lie huddled in the corner of a cave on a cold winter morning shivering because you have no fire, and do not know how to make one. The sun comes out, and you rush out of your cave to enjoy

its welcome rays, but before you have had time to collect your food from trees and ponds, a cloud bursts and you slink back to the darkness and cold of your cave.

MAKING FIRE WITH A FIRE STICK

This is just a glimpse of a fireless world. Imagine the joy and glory of the first man then who rubbed by accident two pieces of wood or flint together and produced a spark. Perhaps he burnt his fingers, or more probably he died of shock. He was surely the greatest of man's benefactors, and the first of our great engineers and inventors. How great and big he must have felt living in a cave bearing a sign that meant, 'Jaju, maker of fire'.

And when he had first made it, how difficult to put it out, or to control it! The Great Fire of London was a mere trifle when compared with the first fire which the dangerous experiments of 'Jaju' the first firemaker set on foot in the jungle near his cave.

There is a very interesting story in Greek mythology which shows how primitive men and races tried to explain things that they did not happen to know.

Men, according to this legend, did not know the use of fire. Only gods in heaven knew how to light a fire, or to use it. One Prometheus, feeling for the misery of a fireless mankind, stole it from heaven and brought it down on the earth. He taught men the use of fire, but he had to pay heavily for it. The god of gods captured Prometheus and punished him by chaining him to a rock where the sun beat hot during the day, and winds blew cold at night. In addition Prometheus had his entrails open, and the vultures preyed upon them.

But do you think Prometheus repented, or asked for forgiveness? On the contrary, he submitted to the punishment as the only reward for daring to do good to mankind! If the god of gods had set him free, he would have gone back to his old self-imposed task of finding out something new and more useful for his fellowmen.

'Jaju' or Prometheus, who it was does not very much matter. It is Man fighting against odds, and suffering the consequences of his unending fight cheerfully. Jaju or Prometheus is the type of the scientist who feels for mankind, and devotes his life to pursuits that add to the comfort and happiness of man. He goes without reward, or like Galileo, he is put into prison, but he does not give up the service of science. He does not often get recognition; many times not even a word of encouragement: but he has his own ideal before him.

It is known of Jenner, the English doctor who established vaccination as a check against small-pox, that he was experimenting for sixteen years before he made

STATUE OF DR. JENNER VACCINATING A SMALL BOY

his discovery public. Even when he had vaccinated thousands of poor people without any fee, and saved them from the deadly scourge, his contemporaries were not convinced. As he obtained his vaccine from a cow, he was caricatured in the newspapers with horns and a cow's face to show what result people might expect from vaccination. But Jenner had faith in the truth he had discovered, and he persisted in saying that vaccination can check small-pox. He tried the effects on his own sons, and in the end he succeeded in convincing his contemporaries that small-pox could be prevented by the means he suggested. He is considered today as one of the greatest benefactors of mankind, though there is still a small number of 'anti-vaccinationists' who think vaccination harmful.

There is no doubt that originally man started to inquire into things out of mere curiosity. He had eyes to see, and a rapidly developing mind urging him to understand what he saw or otherwise perceived. In the beginning we can look upon Man as a human child. The older he grows, the more he investigates the many unfamiliar things that make up his little world in the house where he is born. If he had no one to learn from through 'education', he would educate himself: in many cases he still gets the best education through his own efforts. For example he makes very early the discovery that very hot or very cold things are painful to the touch.

This desire to know things for the sake of knowing them is the highest ideal of science. We have just said that scientists are led to make their important

discoveries by a desire to reduce the sufferings of mankind, and to increase its comfort. That is true only in an indirect way. The greatest of our scientists, at least today, are concerned only with the pursuit of truth. What else it may lead to does not occupy their thoughts for very long.

The best example of these heroic efforts to increase human knowledge is to be found in the many expeditions that have been led into unknown parts of the world. The discovery of the interior of Africa by one explorer after another, the voyages into the South Seas of Captain Cook, are notable examples of human endeavour under very trying conditions. But it is possible to say of these explorers that they were actuated by religious motives, or the desire to extend the power of their own country. Nothing but the simple love of knowledge has led innumerable expeditions into the Arctic and Antarctic regions to find the way to the North and South Poles.

One of the most heroic of these expeditions was led by Scott in 1912. Captain Scott and his four companions pulled their sledges alone for 147 miles in the surrounding wilderness of snow. They carried their own provisions with them. They deposited these provisions in pits in the snow as they went along so that they may use them on the return journey. The party reached the pole on the 18th January 1912, but the march to the pole had been attended with so many difficulties, and so much time had been wasted in overcoming them that unfavourable conditions set in soon after they had begun the return march.

One member after another died of cold, or starvation, or mere fatigue. But all of them showed the same cheerfulness, regard for the safety of others, and faith in the mission they had undertaken. The most heroic of all was the voluntary death of Captain Oates who disappeared so that other members of the party might not suffer through him. He suffered severely from frost-bite, and his companions had to go slower to help him on. When Captain Oates felt that death was upon him, and that by his illness he was putting in danger the life of others, he said to Scott, 'I am just going outside, and I may be sometime.'

With these brave words Oates disappeared into the blizzard that was blowing. He went forward to meet his end like a soldier so that he might help to save others. But even his voluntary death did not save that gallant band of scientists. They marched on and on till March 21st when the party, now reduced to three, was forced to camp on account of another blizzard. They were only eleven miles from a depot where they had deposited at least a ton of provisions. They had very little food with them : hardly enough for two days. The blizzard continued to blow for four days; they were prevented from coming out, they perished in the snow in their tents.

Their remains together with the diary of Captain Scott were not discovered till a year afterwards. It was then that the world knew of their suffering, their fight against the forces of nature, and their triumph over the wilderness of snow.

The death of Captain Scott and his brave companions is only one of the innumerable instances that

show the spirit in which men of science pursue knowledge. In recent times the expeditions that have been led year after year for the conquest of Mount Everest regardless of expense or suffering show the same determination to explore the unknown at all costs.

Nature is like a watchful enemy that never leaves a mistake unpunished. Her laws have no exception; she never goes to sleep and therefore she cannot be taken unawares. Man has conquered her by showing his superiority in overcoming the obstacles put in his way. In order to achieve his end he must see closely and well, his hand must neither fail nor falter; his patience must be great, and above all he must be humble.

These essential virtues of a man of science are very well exemplified in Herschel, the great English astronomer. He was constructing a telescope which was considered one of the biggest in his day. It was fitted with a seven-foot mirror which Herschel had to polish with his own hand. He discovered that the best polish would be obtained if he continued without stopping till the final surface was reached. He kept at it for sixteen hours without taking his hand off even for a second! His sister Caroline put bits of food into his mouth to keep up his strength.

And when this telescope was finished, he undertook to do the almost impossible task of surveying the whole of the sky visible from his observatory. He observed the whole night through: he scanned the sky inch by inch; he let every star pass through the field of his telescope three times, so that nothing

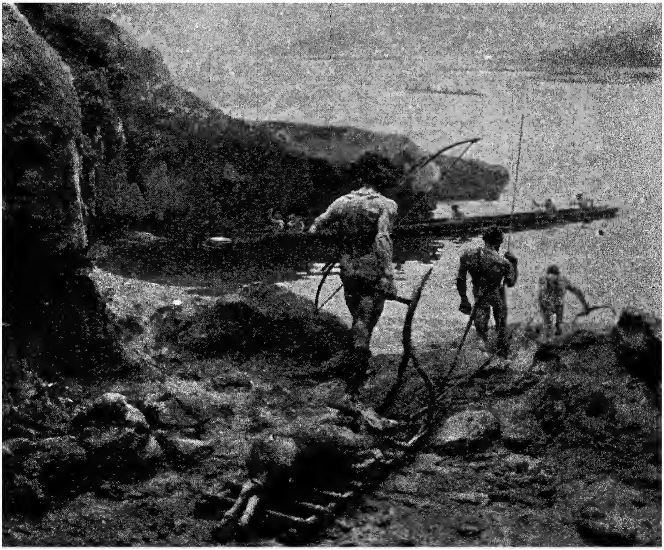
could escape his watchful eye. He continued this task for five years and very nearly succeeded in achieving what he had set out to do.

It is men of the type of Jenner, Herschel, and Scott who have left behind a heritage that makes the twentieth century the wonderful age that it is. They work quietly in their laboratories, or go out into the unknown, and people know little about them till they have done something that the world chooses to call wonderful. But to the student of science himself, whether he is a mere novice or a specialist, his laboratory is his field of battle; all his results are wonderful; all his efforts are directed against the greatest enemy of man—Ignorance.

## CHAPTER II

### *From Wheel to Wheel*

ONE of man's earliest wants must have been to carry things. Having killed a big animal for his food, or collected a large quantity of roots and fruits in season, he must have felt the neces-



EARLY MAN WITH A SLEDGE
*(Reproduced by permission of the Director of the Science Museum, South Kensington, London)*

sity of carrying his spoil to a place of safety. Once deposited in safety in his cave, or somewhere near it,

he and his family could live on it for days, and sometimes in cold climates and seasons for weeks and months.

It seems probable that he used some sort of a sledge made of wood and covered with dry leaves, or skins of animals, to 'cart' his store. He and his family must have done the pulling. The use of animals, such as dogs, oxen, asses, must have come very much later. Apart from the fact that he took some time before he domesticated these animals, the difficulties of carrying things over ground without even a path must have been very great indeed. It seems probable, then, that the earliest form of transport was a load carried by man himself on his head or back. If you have travelled through the mountains where even a mule cannot go, man is the hardiest, and safest means of transport even now.

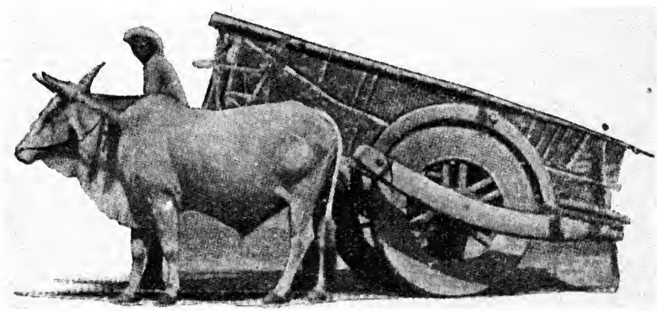
Students of the history of man tell us that the dog, and the horse, were the first animals to be used in the service of man. The ox came soon after and superseded both of them. But curious as it may seem the horse does not seem to have been much used for carrying or carting loads. The man on horseback has always symbolised the man in power;—the leader in peace or war. The ox is the most useful of the servants of man, the most ancient, and the most helpful. Except in very modernised countries of Europe, it is still the only means of transport for heavy goods into the interior of a country.

But the ox did not establish itself as the greatest of man's allies, till man had invented wheels. From the sledge to the roller, and from the roller to the

wheel, man has worked his way up. The progress was not so quick as it seems, for it was only in comparatively recent times that man discovered how wheels with spokes in them are lighter and faster than discs of solid wood with an axle driven through.

The problem of transport, and of man's attempt to overcome distance divides itself into two parts: wheels and the track on the one hand; and energy on the other. It has taken man centuries of toil and experiment to make improvements in either of them.

We become so used to things about us that we take their existence for granted. And yet there must be at least some of you who did not see a railway train



A BULLOCK CART

till you were fairly grown up. Not very long ago when a man went to *Haj* or on pilgrimage to Hardwar, he parted from his friends as if he never expected to return. The journey was long, delays were frequent, and the perils of the road by no means to be neglected. Even when the country had very settled government, and there was peace and plenty all round, travelling was not without its dangers. The old-

fashioned cart drawn by a pair of oxen did not move any faster than the muscular peasant who trotted along under the shadow of the trees at a good four miles an hour. In an emergency he might cover thirty to forty miles in a day, while the cart and oxen with their rich occupant went no farther than a stage.

During the last hundred years man's progress in the means of transport has been really wonderful. The contented peasant trotting along at four miles an hour, and Sir Malcolm Campbell whirring along the sea-beach in a speed car at over 250 miles an hour present a world of contrast not easily understood or imagined. And yet in less than a century this has come about so simply and naturally that we fail to grasp fully the long years of failure and discouragement.

You know the prejudice which most people have against travelling by an aeroplane. It is considered the most dangerous mode of travelling. Only a foolish man will, they say, choose the aeroplane when the safety and comfort of a railway train are available. And yet about seventy years ago the opposition to the construction of railways was so great that many useful projects had to be given up.

The first, if not the greatest, of the English locomotive engineers, the little-known Cornishman, Richard Trevithick, was so disheartened that he left his country and went to South America. He did not return till George Stephenson, the reputed inventor of the 'railway' engine, had overcome some at least of the popular prejudice by successful runs with his first engine, called the 'Locomotion'.

The first man to show that it is possible to move a carriage with its own power was a Frenchman named Joseph Cugnot. In 1769 he constructed a three-wheeled carriage with a big copper-boiler fixed on it for the generation of steam. In 1770 it was tried in the streets of Paris in the presence of a crowd of spectators among whom were many notable people of the day. It carried four passengers, and travelled *by its own power* at a comfortable pace of three miles an hour.

The whole of Paris marvelled at this satanic contrivance that could move without any visible signs of motion. As a reward, and as the result of their marvel, poor Cugnot received no thanks but sneers. The people saw in him a man who held commerce with the devil; a man who went against the laws of God and man. They waited for an excuse, and by chance when he ran his steam-carriage into a wall they put him in prison, and felt satisfied that they had saved France from the mad pranks of a very dangerous man.

The faith and sacrifice of these martyrs of science bear fruit only in the end. They carry in their hand the torch of knowledge which is handed to the next man before he falls a victim to the ignorance of his fellowmen. The work of Cugnot, or of Trevithick was not wasted. The faith of these engineers in the powers of steam survived the ridicule of their contemporaries. George Stephenson, as we have already said, carried further into practice the ideas of his predecessors.

George Stephenson was not a rich man; far from it. He was one of the poorest boys who ever attained

to fame and success. He was born on the 9th June, 1781; his father Robert Stephenson was a poor miner who could not even send his son to school. As George grew up, he was sent out to mind a neighbour's cows and earn his share of the family's small income. By and by he was taken into the coal-mine where his father worked. Young George was fascinated by the steam-engines that carried loads up and down in the pit of the mine. He saw them; he learnt to understand their working, but he did not know *why* they worked in that way, and in no other.

His desire to know more about these engines led him on to reading and writing. He had to start with A B C, because he had never been to school even for a day. All his leisure he spent in the study of books, or in making models of steam-engines, that would move along a track. He showed such cleverness in the management of machinery, that his employer put him in charge of all the machines in the mine. He obtained his master's permission to construct an engine for him to carry loads from one part of the mine to another. The permission was granted reluctantly, because people were afraid that a moving steam-engine would blow up causing destruction.

Stephenson soon showed how baseless these fears were. With the help of the engines that he built, his employer was able to dispense with a hundred horses that had been employed to pull trucks of coal in the mine. When mine-owners heard of the success of Stephenson's engines, they shook their heads wisely, and said, 'He would blow up the mines to the skies.

How can such mad things last for long!' and other unkind words of a similar nature.

But here and there an adventurous capitalist came to see Stephenson's engines at work. One among them was a Mr. Pease who was building a railway about 50 miles long for coaches to be drawn by horses. He was so struck with the possibilities of the steam-engine as a means of locomotion that he ordered Stephenson to build an engine for him. It was built, and it successfully carried coaches and passengers over the railway.

But on the whole Stephenson fared no better than his French predecessor Cugnot. People laughed at him. One of the newspapers wrote, 'We should as soon expect people to allow themselves to be fired off from a rocket as trust themselves to the mercy of such a machine, going at such a rate'. In connection with the last remark, it must be mentioned that people in those days believed that if they moved faster than ten miles an hour such a rush of blood would go to the head that their blood-vessels would burst.

Even some of the men who composed the House of Commons in Stephenson's days had no greater foresight. When an application was submitted to the House for permission to run a steam-railway, a Member of the House of Commons stood up, and asked in all seriousness: 'Was the House aware of the smoke and the noise, the hiss and the whirl, which locomotive engines, passing at the rate of ten or twelve miles an hour would occasion?' Another Member urged, that 'Such schemes were dangerous, delusive, unsatisfactory, and above all, unknown to the constitution of

the country.' He concluded by saying, 'I hate the very name of a railway—I hate it as I hate the devil'. Not only the common people, but even a man like Ruskin, one of the greatest of English writers and a keen admirer of beauty, considered the introduction of the railways one of the curses of his day. He carried on an unending war against the railways, as, in his opinion they were making England ugly and poor.

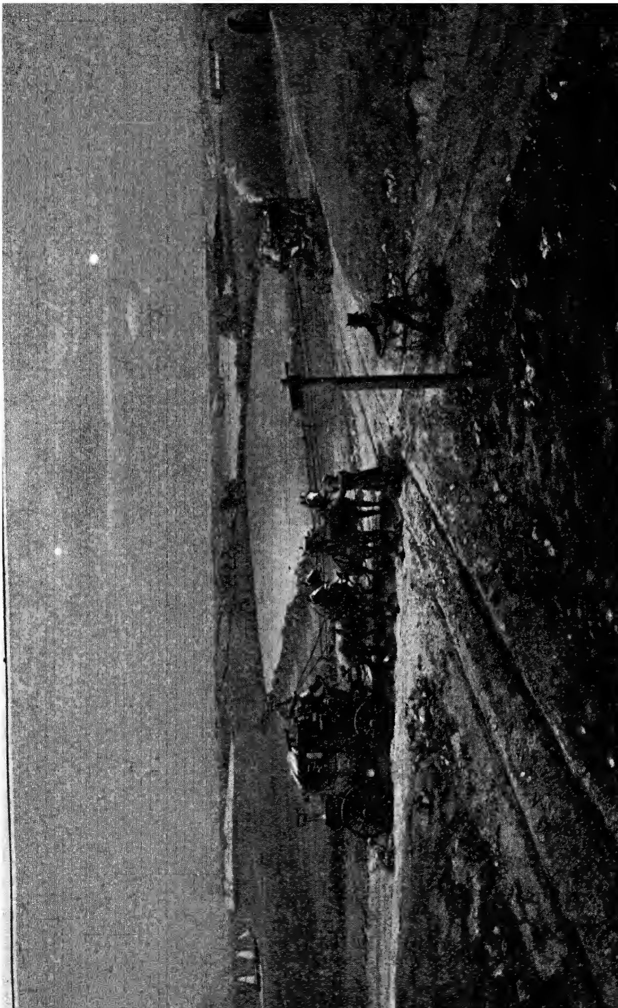
What would these prophets have to say of the modern English trains which cover a distance of more than two hundred miles at an average speed of over seventy miles an hour. What would they think of our ideas of the beautiful and the ugly, when the 'noisy ugly monsters' of their day are called by us types of grace and majesty.

These improvements in the speed, the strength, and the shape of locomotives have been rendered possible by the development of the finest machinery in modern times. The growing needs of the country in trade at home and abroad have urged railway-men and engineers to build better engines year after year. Some of the railways in the United States of America, in Africa, in Canada are marvels of modern organisation. The Canadian Pacific Railway is not only one of the longest in the world, but it claims also to furnish a link round the world. It joins Liverpool with Yokohama. It carries the trade of the Atlantic across to the Pacific and back. It climbs at terrific speed one of the highest mountains in the New World. It manages and puts on the market the produce of the Canadian Forests—one of the richest and most extensive in the world.

The desire to overcome distance has taken hold of the modern mind. Side by side with the railways has grown another mode of travelling no less important. Starting with a contrivance on two wheels propelled by the rider, we have developed the modern bicycle, the motor bicycle, and the motor car. The principal of the internal-combustion engines used in motor cars has not yet been finally developed to its limits. In a few years time the railways and the motor cars will be serious rivals as carriers of the world's trade. The advantage for weight and long distances will always remain with the railway: though considerations of economy, speed, and comfort will always incline us to choose a journey by road. The comfort of a journey from door to door is a very important point in favour of the modern car.

The progress of these road vehicles has not been without very serious difficulties.

In India we do not quite realise them, as we are familiar only with the finished product, but the earlier stages of travelling by road in England furnish a very thrilling narrative of hardship and adventure. While even as far back as the time of the Moghals, caravan after caravan of horses, and camels, and horse-driven carriages passed along the Grand Trunk Road from Peshawar to Calcutta rolling along smoothly over a good road, English traffic lumbered on through country lanes that had been broken knee-deep in mud by heavy horse-driven carts. The dry, hard soil of India has provided us with natural roads that assure us a good surface for miles together most of the year round. It is only during the rains that our country roads



TRAVELLING BY COACH AND HORSES

(*Reproduced by permission of the Director of the Science Museum, South Kensington, London*)

become impassable. But England is a very wet country; her soil at places is very soft, and until about 150 years ago it was an uncomfortable business to travel along one of English roads.

For centuries in England men and goods had been carried on horseback. Since the days of the Romans who were in some ways better road-makers than modern engineers even, Englishmen did not know the luxury of travelling on good firm roads. Even rich people could not move from one place to another with speed or comfort. A carriage drawn by four or even six horses moved no faster than a mile and a half per hour.

As we are told by one writer after another English roads were simply a series of pits filled with big stones and soft mud sometimes two to three feet deep. If a carriage once got stuck, it could only be lifted out by men—horses could not drag it out.

No improvement in travelling was thus possible till the roads were first improved. And little was done until the beginning of the nineteenth century, as men had forgotten the real way to make roads that would last. The Romans had succeeded in building such wonderful roads, because they understood the structure of a road. They compared roads to houses. No one would expect a house to stand if its foundations were not firmly fixed. A road has to carry more weight, and stand more vibration even than a house. Thus its foundations must be more firmly fixed. At the beginning of the nineteenth century this principle was restated by two engineers, Telford and Macadam. No one thinks often of Telford today; but Macadam

is still remembered, for his name became attached to his way of road-making, and we speak of all *pucca* roads as *macadamised.*

These two men made a revolution in inland transport even before the railway or the motor car were as much as thought of. With good roads to run on, with modern machines and laboratories to help in their design and manufacture, motor cars and bicycles have developed very fast indeed. It is possible for us now to foresee a day when no man need walk a yard, except for pleasure!

But good roads alone are not enough for fast travel. Some machine is needed to carry the traveller who wishes to cover long distances in a short time. The earliest form of the bicycle was well called the 'Bone-shaker'—it jolted along on its steel tyres, and fixed wheels. It was not till the discovery of ball-bearings, and rubber tyres, that we really started on the development of modern cars.

In its natural state rubber becomes soft and sticky under the influence of heat, and hard only under the influence of cold. In that state, therefore, it would not be of much use. An American, Charles Goodyear, discovered that rubber could be made independent of temperature by adding to it sulphur which has been melted by heat. The compound thus formed is called vulcanite: and vulcanite retains its firm, elastic form under all ordinary temperatures. By varying the proportion of sulphur, vulcanite can be made as hard as the substance of which combs (and innumerable other things) are made; or it can be made as soft as the air tube of a bicycle.

The discovery of vulcanite and the making of the earliest motor car took place at about the same time. Bicycles and motor cars were then fitted with what were known as 'solid' tyres. Tongas and other horse-driven carriages still have a band of rubber passing round the wheel to give them smooth motion. But with the weight and speed of a modern car solid rubber tyres would be worse than useless. It was a happy thought of Mr. J. B. Dunlop of Dublin that has given us the speed and comfort of an air-filled modern tyre. It is true that long before Dunlop ever thought of it, rubber cushions filled with air had been in use. But no one had ever put two and two together and said, 'I shall provide my bicycle with two air cushions, so that it may not jolt me about quite so much.' Dunlop had this idea, so he retained the old solid rubber tyre, but he hollowed it, so that a rubber tube could slip in between the tyre and the wheel. The tyre saves the delicate tube from injury, and the tiny rubber valve keeps the air at proper pressure in the inner tube.

The friction between the wheel and the axle was so great, that even by constant oiling the axle could not be kept cool. The discovery of an engineer, that well-greased tiny steel balls arranged round the axle, and moving with the wheel, reduce friction to a minimum, and ensure cool running of the wheel, has been applied not only to bicycles and cars but all other moving parts of machines. This simple 'ball-bearing' device has made smooth running of all modern machines possible.

## CHAPTER III

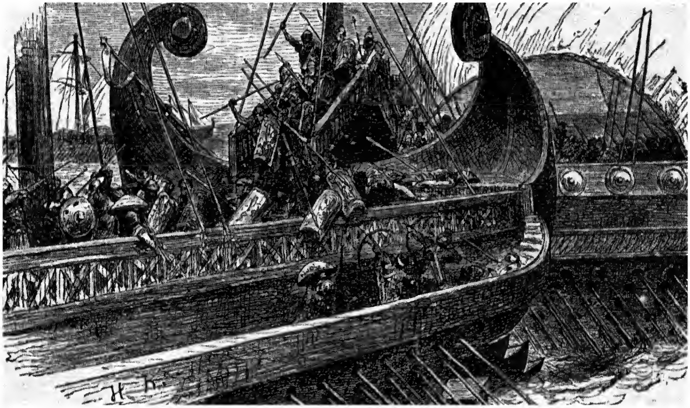
### *From Sail to Steam*

FROM the very earliest time man has devoted as much attention to transport on water as to transport on land. As you know, for every square mile of land there are two miles and a half of water. Besides rivers and ponds gave the primitive man a natural highway the advantages of which must have been seen at once. They were full of fish, and other forms of food, so that almost daily he must have felt the need of sailing on the water. Many great cities and emporiums of the ancient world grew up on the banks of rivers, or on inlets of the sea.

The first boat was probably a log of dry wood that had floated by chance within the reach of an exhausted swimmer. Gradually it took the forms with which we are still familiar : the dug-out and the coracle of the savage people. The dug-out is a simple one-man boat formed from the trunk of a tree hollowed out by cutting-tools, or by means of fire. The coracle is much lighter; it is made like a basket and covered with the hide of an animal. It is generally carried on the back, and used as soon as the man gets into deep water.

Boats were gradually improved by planks of wood being added to the side of a dug-out, till the comparative big merchantmen of the Middle Ages were reached. Nothing new in principle had been dis-

covered by man. All the alterations were in size, in the number of oars used, and the introduction of sails to take advantage of the power of the wind. The use of a rudder to steer the boat in any desired direction has been there from the earliest times. It was probably the result of Man's observation of the movements of fishes and other water animals.



ROMAN SHIPS IN A FIGHT

The Romans had the most perfect ships known to the ancients. There were two types of ships in common use among them: the galleys, and the merchant ships. The galleys were used in war, or for swift travelling. They were long narrow boats with banks of oars-men sitting one above the other along the sides of the boat. Sails were also used when the wind was favourable. But the galleys were not at the mercy of the winds. Some of the war-galleys were manned by two, three, or even four lines

of rowers on each side of the boat, the highest oars were very long and heavy requiring several men to each oar. The rowers were generally slaves condemned to the galleys for life. They were under the supervision of an overseer who stood above, giving the time, and using the whip pretty frequently on the backs of the poor galley slaves whose lives were considered of no value at all.

The Roman merchant vessels had no oars. They were driven by sails only, and the rudder was on the side, and used very much in the same way as a paddle by the boatmen in Kashmir. The modern sailing boat is more or less a development in detail and principle of these Roman vessels. The development took mostly the form of varying the arrangement of sails, so that it was possible for later boats to sail very close to the wind—a feat which the Roman merchantmen were hardly able to accomplish. Nothing really remarkable was, however, achieved till the third decade of the nineteenth century when steam was used to replace the wind as a driving force. And yet so much had been done already by the sailing boat and the bravery of seamen of all countries that the introduction of steam has been able to add only speed and comfort to travelling on the oceanic highways of the world.

From almost prehistoric times Hindus and Arabians in the East, and Phœnicians in the West held the mastery of the sea. There is good reason to believe that parts at least of America were known to the Hindu sailors. It is certain that Phœnician sailors employed by the Egyptian King, Necho II, sailed

round Africa long before Diaz or Vasco da Gama ever thought of a sea-route to India.

Because of their great aptitude for trade and navigation the Phœnicians sailed far and wide across the seas. They founded colonies on the African coast, of which Carthage became the wealthiest, and the most powerful. They crossed the straits of Gibraltar, known then as the Pillars of Hercules, founded a colony in Cadiz in Spain, and made their way to the tin mines of Britain. What has been said of the later British Empire was partially true of the Phœnician, too. 'The trade followed the flag'—wherever the Phœnicians went they established their colonies and trading centres.

With the fall of Carthage the Phœnician power declined. With their decay seems to have been lost much of the knowledge of ship-building and navigation known to them. We have already seen the two types of Roman ships. For centuries afterwards all the progress was along the line of these two types; the galleys were used mostly as men-of-war, and the sailing ships as merchantmen. The galleys employed sails, but did not depend solely on them. Later on in the days of the rising powers of Europe, after the extinction of the city republics of Italy, much impetus was given to navigation by the rivalry of English, Spanish and Dutch sailors on the high seas.

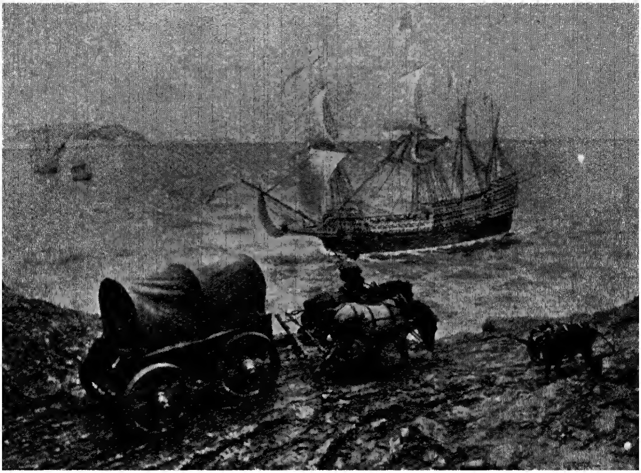
The immediate cause of this renewed activity was the closing of the land route to India. The trade to India with its reputed gold and jewels, its silks and rare spices, was a source of prosperity which the great nations of Europe aspired to capture. The Genoese

sailors, without support or financial help from their own country, put their knowledge at the service of the monarchs of Portugal, the leaders then of the European States. Most notable among them was Prince Henry, surnamed the Navigator, for his love and encouragement of science and geographical discovery. He organised expeditions and sent them round Africa, discovering Madeira, the Azores and other places.

It is noteworthy that most of these expeditions ventured only a little farther from lands already known. They penetrated into the unknown by inches as it were. There was a general belief among all sailors that a route to India could be found by sailing Westward. But no one had the courage to launch their boats into the Great Unknown. It was reserved for the dauntless courage, and ardent faith of Columbus to start straight for the West with only three vessels, the biggest of which was no bigger than a modern river barge.

With the discovery of America, navigation progressed very rapidly. Within thirty years Vasco da Gama had discovered the sea route to India round the Cape of Good Hope; Magellan the greatest of early explorers, had sailed round the world with a mutinous crew of sailors. Under Queen Elizabeth, Drake, and Hawkins, and Frobisher proved themselves as daring as the sailors of Spain or Portugal. All these years there had been a steady improvement since Roman times upon existing models of ships. The indomitable spirit of sailors bent upon facing storms and rough seas discovered new ways and devices to conquer the fury

of the elements. The principal contribution of the sixteenth century to man's conquest of the sea was a

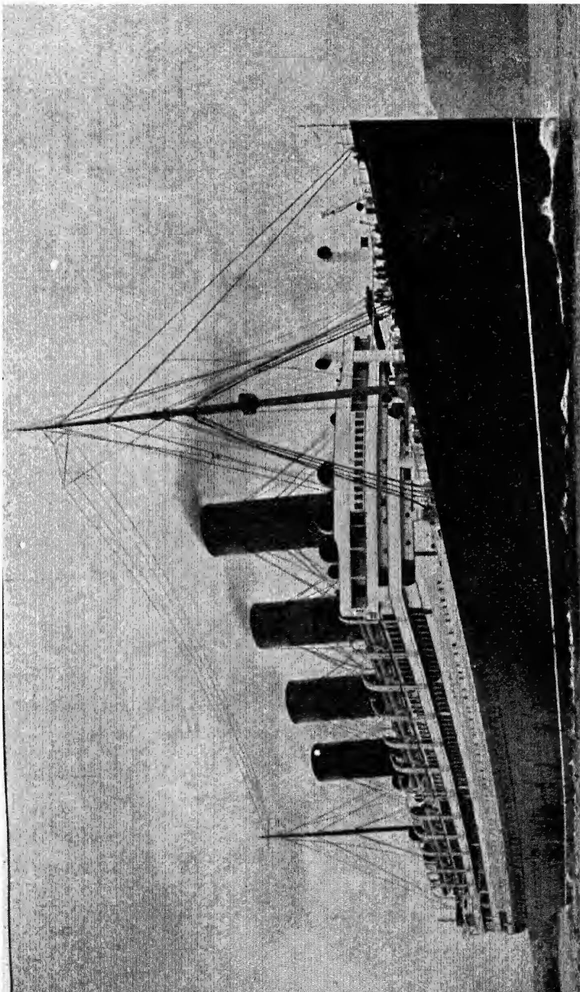


AN ELIZABETHAN SHIP

(*Reproduced by permission of the Director of the Science Museum, South Kensington, London*)

crystallised tradition of seamanship which still inspires the best naval exploits of countries like England.

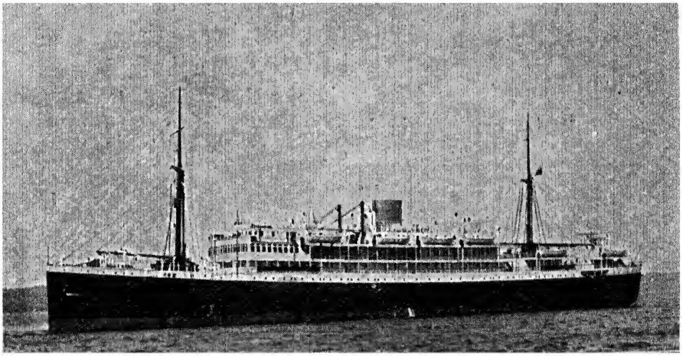
Between the sixteenth and nineteenth centuries Europeans continued their voyages of discovery. All the lands in the Pacific and Atlantic oceans have been gradually discovered and colonised. The discovery of the Australian group of islands by the English sailor, Captain Cook, was quite as important though not half as sensational as the discovery of America by Columbus.



A MODERN PASSENGER STEAMSHIP: The *Aquitania*

(*By kind permission of the Cunard Steamship Co., Ltd.*)

In navigation, as in other branches of human knowledge, the nineteenth century is an age of wonder. The huge monsters of the sea that now ply from port to port carrying thousands of passengers, or hundreds of tons of cargo, could not ever have been conceived of a century ago. Vessels like the *Bremen*, the *Aquitania*, or the *Majestic* are dreams of luxury and comfort. Their tonnage ranges from forty to fifty thousand tons. They accomplish the voyage between Europe and America in four to five days. They carry on board their ships all modern comforts and amusements known to man.



[*Photo: Elder, Dempster & Co.*

A MODERN MOTOR VESSEL: The *Accra*

It is not possible to speak here of the different types of ships now being built in the dockyards of the world. There is a type for every imaginable purpose of peace and war. From the fastest motor boat driven by the late Sir Henry Seagrave at very nearly

a hundred miles per hour, to the heavy cargo boats that carry the produce of Australia to the factories of Lancashire; from the fast cruiser to the mighty dreadnought, there are more varieties than can be catalogued. There are no limits imposed upon the inventive genius of man, and in ship-building the only limits are the resources of a country. Because all these vessels, big and small, are very expensive in the making, the cost of a modern passenger liner would run into several million pounds. For every extra mile of speed beyond a certain limit which it is desired to achieve, the cost of constructing a ship is almost doubled.

But more interesting in many ways than these luxury boats are the ships used for carrying on the trade of the world. A big cargo boat is like a huge box in which every inch of space is of value. But the difficulty is to make this box strong enough. If it is strengthened horizontally by beams as in a roof, the beams are in the way of loading and unloading. If this strength is not given cross-wise, there is danger that the sides of this box might collapse under the great pressure of water. All the experience and skill of ages has gone to the making of these cargo boats. There is a separate type for every kind of cargo. There is, for example, the ship which has come into existence to meet the requirement of trade in frozen meats, eggs, and fruits. It is provided with huge chambers that keep an equal temperature even when the ship is passing through the tropics on a hot summer's day. It is provided with refrigerating machinery, that is to say, with machinery which

creates artificial coldness. If this machinery were to fail for ever so short a time thousands of pounds' worth of goods will be wasted. This machinery is not the only one that comes into play. Not only must the cargo chamber be kept at an even cool temperature, but it must also be insulated against external heat so that the burning rays of the sun outside have no effect on it.

Of the ships of war the most interesting is the submarine. In 1873 a French scientific writer, Jules Verne, wrote a fascinating story called 'Twenty thousand Leagues under the Sea.' In this story he described a ship which moved under the water. Though he had given very vivid details of its working, no one attached any importance to what he had pictured as a possibility. It was a fantastic dream not worth any consideration. But as long ago as the American War of the Revolution, Bushnell had invented one of these ships. It was made of wood, and a magazine containing explosives was built behind. It was intended to work its way under the water to the bottom of one of the British men-of-war, leave the magazine there and retire into safety. It managed to do so, but the magazine exploded a little too late. This idea of Bushnell's gained ground, and in the Civil War in the United States of America many successful experiments were made with submarines. Today they form an essential part of every navy in the world.

A submarine looks very much like a cigar with a flat surface on which officers and men can take their stand when the ship is only partially under water.

There is a small turret which rises above the flat surface. It is called the conning tower. This is the only way for the crew to get into the ship. By the side of the conning tower there is a curious funnel-like thing; this is the periscope, the eye of the submarine. The periscope is a long tube with mirrors and lens arranged so as to catch the image of the objects all around. When the submarine is concealed under the water, the top of the periscope just projects above the water, and catches the image of objects as far as thirteen miles.

By a series of reflections these images are reproduced on a white sheet placed below in the cabin of the captain of the ship. The images look very much like those thrown on the screen by a magic lantern. It will be readily seen that without its periscope, a submarine would be useless.

A submarine has engines to make it go. The fuel used is not coal but gasoline, so that there may be no smoke to attract unnecessary attention. When the submarine takes a dive into the water the gasoline engines are stopped so that the inner atmosphere of the submarine may not lose its oxygen by combustion. Storage batteries are then brought into play, and the submarine runs by electric power. The crew breathes the oxygen which is gradually let off from cylinders of compressed air. An instrument called the manometer shows whether the air is pure enough for the crew to breathe in or not.

The submarine is primarily a means of attack; for defence it carries only a small 6-inch gun with a fairly long range. For really effective defence it will

have to carry several and bigger guns on its deck. Then it would be too heavy to move about with the speed required to chase all kinds of craft on the sea. It has not only need for speed, but also for quiet noiseless motion. Its only safety lies in stealth, as the merest touch from another ship will break open its thin steel shell and send it to destruction.

The submarine is provided with a double set of rudders. One set works in the ordinary way moving the ship right and left. The other set works parallel to the surface of the water and makes the ship dive down or come up. The depth to which the ship can dive depends on its strength, because with every inch the pressure of water on its surface increases and tends to crush it on all sides. There is a pressure gauge which shows in this manner the depth at which the submarine is moving. The submarine cannot be brought to a standstill under the water. It must keep on moving up or down, or forward. It is only on the surface of water that the submarine can be anchored like an ordinary ship; or it can lie still on the bottom of the sea.

The deadly weapon with which a submarine attacks its victim is called a torpedo. The torpedo is itself a small submarine; only it has no crew. It works automatically; it is provided with a nose cap, and a pointed needle. The nose cap gradually unscrews itself, and by the time the torpedo reaches its target, the enemy ship, the needle is laid bare. As soon as it comes in contact with the hard surface of the ship's side, the needle explodes the powder contained in the torpedo, and blows up the mightiest man-of-war. The

whole success of this operation depends on the accuracy of aim with which the torpedo is let off from its hole in the side of the submarine.

You have seen how with the discovery of steam as a form of energy, man has been able to bring about a complete change in the means of transport and travel. Distance has neither fear nor charm for him now. All places of the earth are linked together: there is nothing strange or unfamiliar. Markets of India offer the fruit of the West fresh from the plant, as the markets of the West put forth for sale all the rare products of the East. The world is now one long bazaar, and men go about in it buying and selling with perfect ease and satisfaction.

## CHAPTER IV

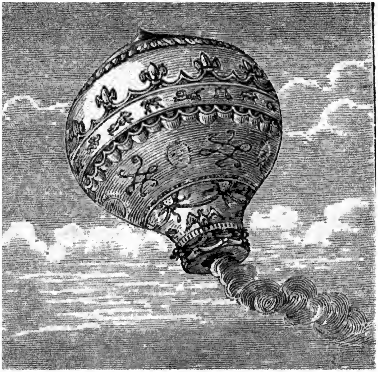
### *Wings*

IN the Ancient Indian Epics, the *Mahabharatha* and the *Ramayana*, we read of kings who used flying machines. It is said of Rama, the king of Ayodhia, that he flew to his capital after his victory over the king of Lanka. His queen, his brother, and his friend Hanuman accompanied him in his aerial car.

It is very difficult to prove or disprove this story. Even if the Hindus knew the secret of aerial flight, it was lost by the times recorded in history. But the story shows how men have always dreamed of rivalling the birds of the air; how swift and graceful movement through the air has appealed to their imaginations. From the earliest times efforts have been made to rise into the air, and to know what 'it feels like.' An Italian artist, Leonardo de Vinci seriously studied the possibilities of constructing a flying machine. But there is an earlier tradition that speaks of an English monk who made an attempt to fly in Spain even before the Norman Conquest. It was not, however, till the year one thousand seven hundred and eighty three that a definite attempt was made to travel through the air.

Two young Frenchmen, the sons of a paper merchant, named Montgolfier, constructed a balloon and put a sheep, a cock, and a duck in it. Like a Noah's Ark of the air, this French balloon took these queer

creatures up before ever man ventured to fly into unknown regions of the upper air. The balloon ascended gracefully to a height of about 1,500 feet, remained at that height for a while, and then gradually it fell through the air till it reached the earth.



AN EARLY FIRE BALLOON

In the same year another attempt was made to fly. This time the experimenters themselves, M. Rozier and Major Arlande, became the passengers. They ascended in a big balloon in the presence of a crowd anxiously watching the result of their daring experiment. The aeronauts seemed to take it very cheerfully, and earned the admiration of the bystanders by waving their hats to them. This balloon is supposed to have reached a height of 3,000 feet above the earth. They remained in the air for quite half an hour.

The year 1783 seems to have been a time of remarkable activity in flying. A third attempt, this

time with a balloon filled with hydrogen, was made by another Frenchman named Charles. Working on these discoveries the English Channel was successfully crossed in a balloon. During the following years of the century flying in balloons was seriously studied in France, and many trial flights were made successfully by French scientists.

During the major part of the nineteenth century, the minds of men were too occupied with industrial and economic problems to regard flying as anything more than a mere whim of some mad scientists. It was not till the last few years of the nineteenth century, that scientists began to explore the possibilities of flight. But the differences of opinion among them were so acute that quite often it was declared that the achievement of flight by man was an impossibility.

An American Professor, Langley, however, held a different belief. During 1887-1900 he studied in theory, and by experiment, the conditions of stability in the air. He proved that the old belief based on the laws of the famous mathematician Newton was wrong. It was not true that an object moving in the air would meet with so much resistance that enormous power would be required to keep up its motion. Professor Langley proved by experiment that on the contrary an object moving through the air could balance itself, if it was moved fast enough. He constructed models to show that his conclusions were right. But in spite of these demonstrations no one believed in the theories advanced by him, or in the possibilities of aerial flight.

No one believed in the theories of Professor Langley, except perhaps two unknown mechanics, the proprietors of a small bicycle repair shop in Dayton, a town in the Ohio State of the U.S.A. They were not 'men of science', nor had they ever been to a college or a University. But they were men trained to do things with their own hands, to observe minutely, to draw no premature conclusions, and to test the conclusions when drawn. They did not understand the technical principles underlying aviation, but they had read with great interest accounts of the experiments in gliding by European and American scientists. But above all they had studied the movements of winds and of birds. They had 'wasted' their youth flying kites when they had nothing better to do. The two brothers, Orville and Wilbur Wright would lie for hours on their backs and amuse themselves with watching hawks and buzzards as they wheeled and circled overhead.

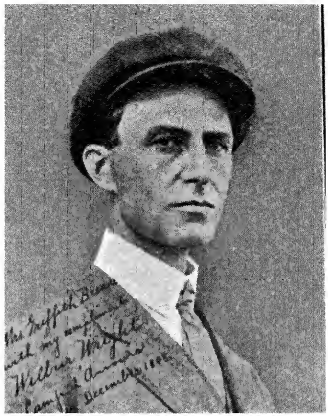
For several years the Wright brothers could arrive at no definite conclusion. The theories of the scientists did not agree with their own observations and experiments. In the beginning of 1900 they decided to build a glider according to their own design, and to try it under the most favourable circumstances. They enquired from the United States Weather Bureau and learned that Kitty Hawk, in North Carolina, was just the spot where steady and strong winds blew. In October of this year they pitched their camp on top of the hill, and on the windswept sand dunes of Kill Devil Hill they started their study of the laws of the air.

For the next three years their life was spent in patient toil between Kitty Hawk and Dayton. The autumn was spent in experiment on the top of the hill with gliders which were built in their modest workshop through the rest of the year. It is only a bad workman who quarrels with his tools : Orville and Wilbur were content to set right all the faults they discovered in their machines with the tools they had in their tiny repair shop.

In the end of 1903, these brave mechanics had built for themselves a machine run by a twelve horse-power gasoline engine intended to give a speed of thirty miles per hour. The planes which balance a flying machine like the wings of a bird; and the rudders which change its direction like a bird's tail were also of their own design and making. A seat for the pilot was built in between the planes very much in the same way as the seat in a modern machine.

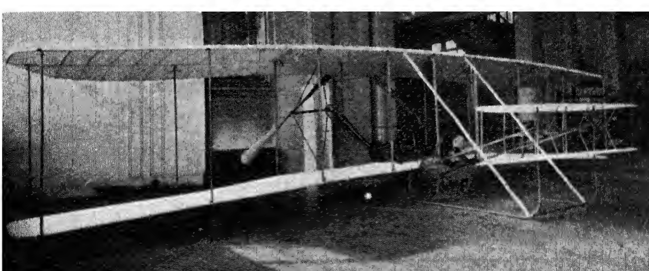
At last on December 17, 1903, rising into the cold raw air of the bleak North Carolina coast, one of the brothers guided this first biplane on its maiden flight. For the first time in history a self-propelled aeroplane had made a free flight and landed back in safety. They made four more successful flights, the last continued for fifty-nine seconds, and covered a distance of eight hundred and fifty feet. The brothers were happy, but not noisy about their achievement. As Wilbur put it, 'the age of the flying machine had come at last'. Once more the 'impossible' had been done; though only two years before, the well-known astronomer, Simon Newcomb, had declared, 'the construction of an aeroplane that would carry even a single

man requires the discovery of some new metal or some new force'



[*Photo*: *Rischgitz*

WILBUR WRIGHT



[*Photo*: *Rischgitz*

WRIGHT'S AEROPLANE

(*Courtesy of Science Museum, South Kensington*)

The rapid advance in air navigation during the last generation is directly due to the success of the Wrights

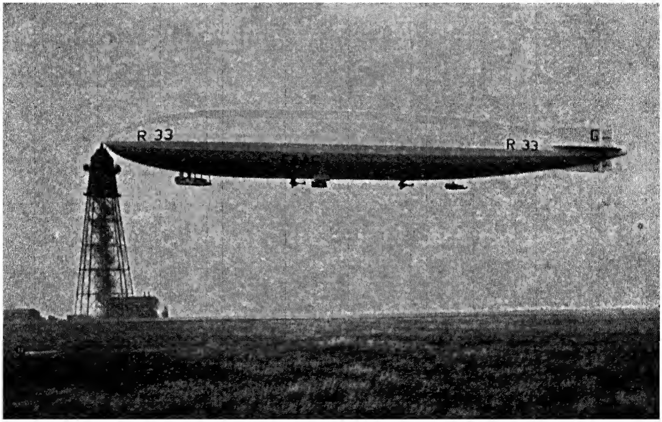
and to the great European War of 1914-18. The Wrights were peculiarly modest people; they did not rush into newspapers, and it was not for another four years that their work was generally known. Engineers of other countries had in the meanwhile arrived at very similar conclusions, and built similar machines in Europe. But the type perfected by the Wrights was adopted in most countries and handsome royalties paid to them for their patents. Wilbur Wright died in 1912, but before his death honour and wealth had both been his. Starting as mechanics, these brothers had made for themselves a name; they had been honoured by universities, and by senates of all the leading countries of Europe and America.

The life and death struggle into which Europe entered on the 4th of August in 1914 made the aeroplane one of the most deadly weapons. Airmen on either side vied with each other in performing deeds of daring that send a thrill of joy and sorrow at the thought of such superhuman skill and courage applied to so base a use as the destruction of mankind.

The aeroplane is a machine heavier than the air. It has power to rise above the earth, power to remain there, and to come down at the will of the pilot who works the controls. From the 'Moth' which is a small one-man machine not very much bigger than a luxury car, to the aeroplane that carries a few tons of parcels and letters and half a dozen passengers, the principle is the same as in the flight of birds. A body heavier than air rises by its own power, and stays in the air so long as that power is maintained. For swiftness of movement, for endurance, for rising to

great heights, for the sheer conquest of the air, this type of machine is unsurpassed. To fly three hundred miles an hour, to float within a few yards of buildings and spires, to whirl round and round till the onlookers standing firmly on the earth begin to feel dizzy at the daring tricks of the pilot, are some of its ordinary achievements.

Side by side has grown up another type of flying machine even more wonderful: the airship as distin-




[*R. A. F. Official: Crown copyright reserved*

AN AIRSHIP AT ITS MOORING MAST

guished from the aeroplane. An airship is a monster of the air, almost as big as a steamship. It is the direct descendant of the balloon; it is filled with gas much lighter than the air; but unlike the balloon, it is not a victim to the vagaries of the wind. It has powerful engines that drive it about through the air.

Of course it must be clear that an airship cannot come down on earth. As soon as its empty air-tight chambers are filled with gas, it floats majestically into the air, and has to be anchored to a high mast. Lifts are provided to take the passengers up and down.

Till recently the construction of airships has been in an experimental stage only. The first man to build airships on an extensive scale was the German Engineer, Count Zeppelin. It is after him that the airships of this type are called. During the last war German airships successfully raided England and France with heavy loads of bombs. But fortunately nowadays much attention is being devoted to the fitting out of these vessels as passenger ships of the air. Big German airships have performed several voyages between Europe and America carrying at a time as many as fifty passengers and other cargo.

It is a very sad reflection to make that all this progress in aviation has been the result of a spirit of suspicious rivalry of what other nations of the world are doing. There is hope in the fact that nations are also beginning to realise how senselessly destructive it would be to try to fight in the air. Because even a squadron of aeroplanes will not be able to defend a single city, much less a whole country. What will probably happen is this: *A* will attack *B*, and *B* instead of trying to defend itself against *A*, will attack *A*; the result: complete destruction of the civil population of both *A* and *B*.

Perhaps it is a knowledge of this very clear warning that is leading nations of the West to develop civil aviation. The whole of the British Empire is

now linked by a series of air-services. A regular weekly aeroplane service exists between London and Karachi. Within a few years many people will travel to England by air, and cut down the time taken by the journey to about one-third of what it is at present. The recent success of flights to Australia, particularly that by Amy Johnson, a young English woman, only 22 years of age, shows the possibility of covering very long distances even in incredibly short time.

There is a glorious future before both airships and aeroplanes. It stretches as far as man can see. The blue sky is peopled with men flying as easily as the birds of the air; rising up and coming down with as much ease and unconcern as a boy who puts off in a light boat to enjoy an hour's row on the river. There is only one dark cloud that hangs above, and mars the beauty of this vision by its sinister ugliness. It is the dark cloud of human jealousy that is urging nations to build more and more of these air-machines, not for the good and comfort of mankind but for its destruction in War.

There is no reason to lose hope. Man is apt to make these mistakes. Those who have faith believe in the ultimate destiny of Man.

## CHAPTER V

### *A New Aladdin's Lamp*

STEAM-ENGINES, motor cars, and aeroplanes are of great and growing use to man. But none of these forms such an essential and intimate part of our lives as the mysterious 'force', called electricity. Our knowledge of this great force is still limited. A hundred years ago we did not even know what electricity is capable of doing. Today we feel there is nothing that electricity will fail to do: it can haul a train of one hundred loaded trucks at fifty miles per hour with the ease with which it turns the finely adjusted needle of a galvanometre. All that man has to do is to put a switch on. Put it on, restore the current, and the thing is done: put the switch off, cut off the current, and the mysterious agent disappears like the Jinns that Aladdin called into existence with his wonderful lamp.

The name electricity is derived from a Greek word meaning amber. The Greeks knew that a piece of amber rubbed hard attracted light substances like straw and chaff. For centuries that was all that was known of electricity: an isolated fact that never excited anyone's curiosity to enquire further. Another fact known but not connected with it by the thinkers of those days was the lodestone—the mysterious piece of iron ore that attracted other pieces of iron towards it and when allowed to swing freely always pointed north.

For long that was all that men knew about electricity and magnetism. Gradually scientists began to make further observations and our knowledge of electricity grew. But from the sixteenth to the beginning of the nineteenth century nothing of any real value was discovered; electricity and its mysterious phenomena were still the playthings of science, its sparks and sputters the toys with which people thought scientists amused themselves.

But the amusements of serious-minded scientists are the basis on which scientific advance is built up. The Leyden jar, the Voltaic pile, and the Electric machine with which young boys and girls get their first lessons in electricity were in their days things of the highest importance. They paved the way for the momentous discoveries of the early nineteenth century. Benjamin Franklin, after a series of experiments, taught what seems to us obvious today, that the lightning in the clouds is the same thing as electricity. For years scientists were labouring to prove what they suspected to be fact, that electricity and magnetism were the same, and one could be changed into the other.

It was the discovery of this simple fact that made electricity such a useful force to man. Our electric motors and dynamos work on this underlying principle. The man who made this all-important discovery was, once again, a very poor, humble, and self-made man. Michael Faraday, the son of poor parents started life as a newsboy and a book-binder's apprentice. Through the kindness of friends he was privileged to attend lectures at the Royal Institution of

Science. Through his zeal, and the promise that he showed, he secured the post of a laboratory assistant at the Institution. There he worked with the famous scientist, Sir Humphry Davy, who is known as the inventor of the miner's safety lamp. Faraday's earlier work was in the field of chemistry, and he had already become famous and succeeded Davy as the Director of the Institution before he turned his attention to electricity. In 1831, he discovered by a series of memorable experiments the laws which govern the relation between magnets and electric currents. These are the laws which form the basis of modern electric appliances such as fans, water-pumps, bells, and all the other machinery so extensively used in our homes and factories.

As Faraday's skill in experimental science became known, capitalists and manufacturers of England and other countries offered large sums for his professional advice. But Faraday chose to disregard all this demand upon his time. He had dedicated his life to science and he persistently refused to waste it in the pursuit of wealth. It has been estimated that Faraday could have easily amassed a fortune of at least three crores of rupees if he had put to commercial use such discoveries as he had made. But the ambition of Faraday was not to add to human wealth but to human knowledge. No other man of science has shown greater unselfishness and greater devotion to truth for truth's sake.

The field of electrical research has considerably widened since the days of Faraday. We owe more inventions to electricity than to any other single force.

To mention only a few: telegraph, telephone, moving pictures, talking pictures, wireless telegraph and tele-

MICHAEL FARADAY

phone, X-Rays for medical treatment, electric railways and other electric machinery for every conceivable use. There is hardly any department of life,

hardly any village even in India, where some invention or other based on electricity is not to be found. We shall speak of some of these wonderful contrivances in a following chapter; here we want to understand what electricity really is, and to tell you of the one man who more than any other has made these appliances possible.

Electricity then is the basis of all matter. There is nothing in the universe without 'electricity' in it. When an electric switch is put on and the lamp is lighted, or when a message is sent over the telegraph wires, some people imagine that a fine fluid has been made to flow along the wires by some mechanical means in very much the same way as water flows through the pipe when the tap is turned over. Nothing of the sort : electricity is not a fluid. Electricity, as we said, is 'force', or energy which all material things possess. Matter, as you know, is resolved into ultimate atoms : and atoms, they say, are composed of units of electricity arranged in certain ways. To produce electricity is to set some of the electricity of these atoms free. In some substances like copper and silver this is done easily; therefore we use copper wires 'to carry' electricity from one place to another. In other substances like porcelain electricity can be induced with great difficulty; therefore we use them as insulators. The white, round pieces fixed on top of telegraph poles are made of porcelain.

We have today two different schools of scientists : one like Thomson, Rontgen, or Rutherford, bent upon finding out the whole truth about matter, and energy, and the universe itself. Their object is the pursuit

of truth for truth's sake. The other school is represented by men like Edison, whose aim is to harness the forces of nature and to make them do man's work for him. We shall not attempt to talk of the work of men like Rutherford because it is too difficult for us. They talk of things which ordinary minds cannot even grasp. But we all know Edison and what he has done for us. He has added to human happiness: he has given us the radio, and the cinema, he has given us the electric lamp that turns night into day in our homes.

Edison was a typical American full of energy, and plenty of common-sense. He worked out his inventions by known laws of science. He had one eye on the needs of everyday life, and the other on the advance in scientific knowledge. The secret of his success and inventive genius was untiring patience and hard work. He believed 'genius is one per cent inspiration, and ninety-nine per cent perspiration', and said so. For days together he could do without sleep when in the pursuit of a new idea, or engaged in the perfection of an invention. Even when he was very nearly eighty years of age, his wonderful energy showed no signs of abatement. He had a very remarkable career. The story of his life is one of those that inspire us to great effort to cultivate the talents with which we have been born.

He was born in February 1847, in a small village in the United States of America. His father, quite a clever man, never came to much, because he was one of the rolling stones that gather no moss. He never settled down to an occupation. Edison was a

thoughtful little boy, but so inquisitive that his teacher thought him stupid because of the ceaseless volley of questions with which he exhausted the poor teacher's patience. So his mother, who had been a teacher herself took him from school at the end of two months and a half and taught him at home. He showed very rapid progress now, and soon established a small laboratory in the cellar of his house.

At twelve he decided to start out in life for himself. From that day his life became one long series of adventures. We cannot speak of every one of them, but here is one that proved to be a turning point in his career. In the spring of 1869 he was temporarily thrown out of a job, and had come to New York to interview one of the directors of a telegraph company whose main business was to supply information to various brokers' offices of the city about the prices in the market. Edison had just stepped into the waiting-room of the office and taken a seat when the complicated instrument with which the information was supplied came to a dead stop. Within two minutes, more than three hundred office boys had crowded into the office and stood yelling and jostling each other in the street outside. The man in charge lost his head. The superintendent of the office rushed in, frantic and excited. Coolly Edison walked up to the instrument, looked at it leisurely, studied its parts, and made up his mind as to what the trouble was. A contact spring had broken off, and fallen between two gear wheels. He spoke to the excited superintendent, told him what the trouble was, and volunteered to set it right. 'Fix it! Fix it! Be quick', shouted the superintendent, as

the noise in the office and outside was increasing with every minute of delay.

In a few minutes Edison had set the instrument going; the noise had subsided; the superintendent was smiling once again; and Edison waiting patiently for a job. Dr. Law, the superintendent, looked at him critically now, asked him many questions, was convinced of his expert knowledge, and offered him a job at three hundred dollars a month—a salary which had been beyond the dreams even of the ambitious youth. Edison says, 'This was such a violent jump from anything that I had ever seen before, that it rather paralysed me for a while. I thought it was too much to last for long; but I determined to try and live up to that salary, if twenty hours a day of hard work would do it.'

And for some years to follow he worked as hard as he had never done before. He opened a laboratory of his own, and spent in experiments every hour he could snatch from his work in the office. He frequently worked straight through the night, displaying that utter indifference to sleep that was characteristic of him throughout his life. Before many months he had patented several improvements in telegraphy, the chief among which was a device by which two messages could be sent over the same set of wires. One day the president of the telegraph company called him into his office and said, 'Now, young man, I want to close up the matter of your inventions. How much do you think you should receive?' Edison says, 'I had intended to ask for five thousand dollars, but I was prepared to come down to three if necessary.' He

goes on to say, 'When the psychological moment arrived, I hadn't the nerve to name such a large sum, so I said, "Well, sir, suppose you make me an offer". Then he said: "How would forty thousand dollars strike you?" This caused me to get as near fainting as I ever got. I was afraid he would hear my heart beat. I managed to say, "I thought it was fair".'

Edison now went on from success to success, from invention to invention. The needs of the moment always suggested his line of enquiry. Duplex telegraphy by which, as we have said, two messages could be sent, was followed by quadruplex telegraphy. The gramophone, the electric motor, the incandescent lamp, the perfect telephone transmitter, the moving and talking pictures all came in quick succession from his brain which never seems to have stopped functioning or to stand in need of rest.

The inventions of Edison have shown how gradually all the work of life will come to be done with electricity. In European countries people go up and down the stairs in electric lifts, or stairs moved by electricity. Your food can be cooked, and kept hot or cold by electricity. The visitors to your house can be announced to you by the ringing of an electric bell, the door can be opened, (and closed after them), by the pressing of an electric button while you are sitting ten rooms away from your outer door. These and a thousand other things can be done for you by this faithful servant that never complains, that never seems to want rest, that gives the same instant cheerful service night and day. This is electricity, the newly found, uncomplaining hand-maiden of man.

## CHAPTER VI

### *From Comfort to Comfort*

THE history of the civilisation of man is a study of man's efforts to make himself comfortable by saving time and trouble. At a time when day after day of his existence on earth was spent in fighting the physical necessities of life, there was no leisure left to him. He did not have the time to do anything but collect his food, eat it, and sleep away his time. The pictures on the walls of caves in the very early periods of human history show how, from the first, Man has expressed his desire for beauty, relaxation, and amusement.

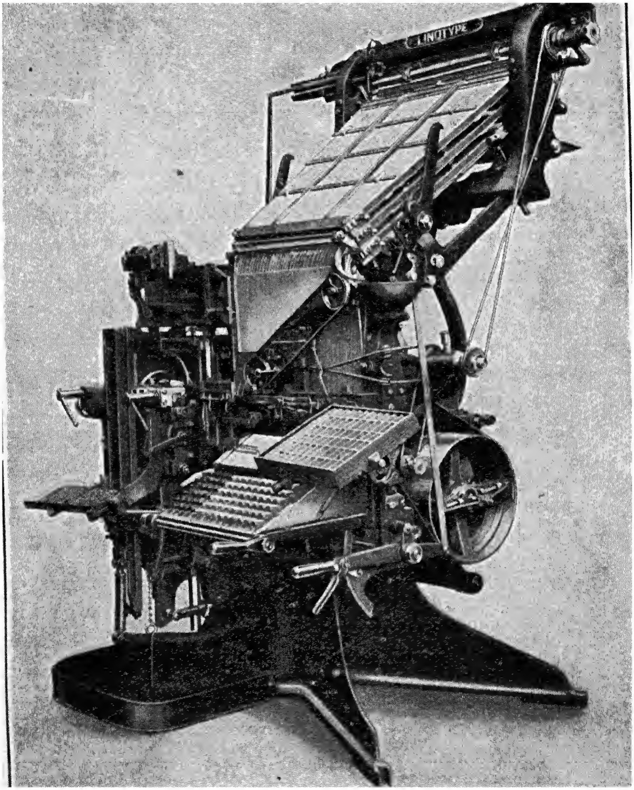
But these are possible only to those men who have the time for the cultivation of their minds. Therefore we are not surprised to find the most primitive people inventing 'machines' to economise time and trouble. When the first Man balanced himself across a stream over the trunk of a fallen tree, instead of wading or swimming through the water, he had discovered the first bridge that man ever built. When he used a piece of wood as a lever to roll a heavy log of wood, he laid the foundations of the science of mechanics. When he used the interwoven branches of a tree, or made a rope from the fibre of plants, he had started well on the way to construct a modern engine. The falls of Niagara, that run huge turbines, and generate electricity enough to supply all kinds of

energy over an area 300 miles away, are only a development of the prehistoric water-mill and the grinding stone.

Human ingenuity and inventive skill have reached marvellous perfection in our own times. There are machines, big and small, that seem to imitate the human brain. They leave absolutely no margin of error; their precision is like nature's own, without flaw or variation. Take for example, the linotype machine for composition. The old method of printing was from individual letters of the alphabet cast in varying moulds known as *types*. The compositor had the manuscript spread out before him; in his left hand he held a metal slip with a channel or groove cut into it. The letters were contained in a shelf with a separate pigeon-hole for each letter—the capital letter above the small. The compositor took out one letter after another, put it in the groove, and when the line was complete tied the whole with a string. Line after line was thus completed till the whole page, or 'form', consisting of eight pages, was composed. After the printing was over, the lines were decomposed, and thrown into a heap, called the 'pie' by printers. It required great labour and time to pick out letters from this pile, sort them, and to restore them to their original shelves for the use of the compositors.

The linotype does away with all this cumbersome waste of time and energy. By a series of devices the composition and 'decomposition' are all mechanically performed. This machine is the most wonderful thing in the printing industry. It almost thinks like the man whose thoughts it sets into type. Like the

typewriter it has a keyboard before which the operator sits. He presses down a key with as gentle a touch




A LINOTYPE COMPOSING MACHINE

*(By permission of Linotype & Machinery, Ltd.)*

as the typist, or the player on a harmonium. As fast as his fingers move, so fast does this machine set

letters into words, and words into lines. That is why it is called the *linotype*.

The machine was invented by Ottmar Mergenthaler, but has been much improved by other experts. It works in various parts. As the operator presses the key down, it releases the desired letter which falls down through a groove built under the reservoir where the brass letters are stored. There is a separate groove for every letter and mark of punctuation. The grooves all end on a strap which is revolving as the machine is working. As the letter falls on the strap, it is carried along it to a small chamber which represents the line to be printed. As the keys are pressed one after another, the letters fall through their grooves one after another, are carried along the strap in their proper order to the empty chamber.

As soon as the line is complete, automatically another part of the machine is set going, while the first part continues uninterrupted its work of composition. The letters that have been set into a line are carried to the top of the machine till they rest against a slot in a wheel. This wheel is connected with a copper of boiling metal which is forced into the slot behind the line that has been composed. A heavy punch presses the letters into the boiling metal which is cooled to form a mould of the line.

Here comes into play the most wonderful part of the machine. As soon as the line has been moulded, the wheel turns, the slot is emptied, and the letters composing the line are carried along an iron band while they are being thus carried they are separated, and fall each into their separated groove. They are

ready again to start on their journey through the machine as soon as their turn comes, and the key that releases them is pressed by the operator. In the meanwhile the line that had been cast in molten metal is carried to another chamber where the set lines are stored to form the page. These pages are taken out and set in their proper places in a printing machine, and printed off. When the set lines are no longer required, they are thrown back into the machine to be melted and used for fresh moulds.

This is only one example of many curious and wonderful machines in one industry out of millions now pursued by man. The trains that carry millions of human lives over the tracks of the world employ innumerable devices for their safety. To guard against accidents, a number of simple but efficient contrivances are placed on every station and every train. It must be clear that the greater the speed of a train, and the greater its load, the more difficult it is to pull it up in an emergency. Before the modern system of braking it used to be the practice for every train to carry its own brakesman. He travelled in a carriage, part of which was used for the brakes worked with a wheel. He was responsible for applying the brakes when the need arose. But the brakes applied to the wheels of a single carriage cannot stop the wheels of a whole train. The accidents due to running away of trains down slopes, or before a sandstorm, or when face to face with a herd of cattle that had strayed on to the railway track were quite frequent.

There are today two different systems of brakes by

which it is possible to stop a heavy goods train moving at a speed of thirty miles or over, within a negligible distance. A fast passenger train moving at sixty to eighty miles will begin to crawl at the touch of a lever. Both the systems make use of air—one through creating a vacuum, the other through compression. You are all familiar with a chain or handle provided in every carriage. In an emergency you are advised to pull it out. It really operates a lever which applies the brakes of your carriage and of the whole train. As soon as the chain is pulled out it releases a valve in a vacuum drum put under every carriage, the air rushes in and the brakes drop down against the wheels. To lift the brakes again, the driver of the train creates the vacuum again by steam. As the air of the drum is gradually taken out, the brakes gradually rise. Attached to the emergency chains of every passenger carriage is a small signal. As the chain is pulled out this signal is thrust out to tell the guard where and when the chain was pulled.

The other system of brakes works in a similar fashicn—instead of the vacuum the drums and brakes are worked by compressed air. Both the systems are automatic and instantaneous. That is to say, the pulling out of a lever applies the brakes not only of the engine, an individual carriage, or the brake van, but of the whole train, because the brakes of every carriage are connected with the rest by a canvas hose pipe that you can see hanging between the chains that couple one carriage with another.

When we realise the great gain in speed and safety which has resulted from the introduction of these

brakes, we feel grateful to the inventor, George Westinghouse, who was almost a boy when he made this great improvement in the system of braking. We are told that Westinghouse was a typical boy. He was very fond of play, and he disliked school. His father was an inventor of some note, and the owner of a carpenter and machine shop. He did not quite approve of young George's truancy, or of his constant meddling with tools in the shop and making contrivances which he regarded as mere 'trumpery'.

Once the elder Westinghouse led George to a pile of pipe and told him to cut it into pieces of a certain length. 'I am going away for a week. This will give you some work to do during my absence.' Young George who had formed his own plans for play was sorely disappointed, but not disheartened. Within a few hours of his father's departure he had rigged up a combination of tools, which, when attached to an engine automatically fed the pipe and cut it into required lengths.

A few years later another occasion very similar gave us the famous Westinghouse brakes. One day, when he was hardly twenty, he was travelling by a train which came unexpectedly to a standstill. Going forward to learn the cause of the delay, he discovered two battered goods engines and heard the story of a head-on collision. 'But why', asked Westinghouse from one of the railway officials, 'should this collision have occurred?' The railway line was perfectly straight and visible to drivers for miles ahead. One of the drivers said, 'We saw each other. We tried to stop, but we couldn't.'

'Why not?' said Westinghouse. 'Wouldn't the brakes work?'

'Oh, yes. But there wasn't time. You can't stop a train in a moment.'

But Westinghouse believed you could. He conceived the idea of a brake that would work throughout the train and he designed the brake that we have already described.

Westinghouse became a great inventor in railway and electric works. He gave us the 'interlocking' system of points on a railway. The entrance of a train to every station is controlled by a system of points which set the lines in one direction or the other. The points are opened by keys. Westinghouse designed a simple key-box, so that if you set the point in a certain direction, you could not take out the key for the point which controls the entrance to the same line from the opposite direction. So that by this simple device the risk of collision is very much reduced. He also devised various methods by which the movements of trains between one station and another are watched and controlled from the so-called station 'cabins.'

The whole history of invention in the last century or so is the history of human effort to save time and trouble. Some of these inventions have become so very common that we never give them a moment's thought. Such are the household sewing machine, and the typewriter. By a series of improvements we have now sewing machines for almost every purpose—for embroidery, boots and shoes, thick canvas and leather, button-holes and buttons, and everything else

where any stitching has to be done. The principle underlying the construction of the typewriter has been used to give us various calculating machines that add up figures up to millions, that multiply, subtract and keep account of cash sales. Every modern business house is now equipped with one or more of these machines. They replace human labour, and make the lives of workers in business less strenuous.

So far man has discovered five chief sources of power that he is using extensively to drive his mechanical inventions. There are, first, the two elemental forces, wind and water. The wind fills out the sails of his ships and drives them across the seas; it drives his windmills and gives him energy without any expense. But 'the wind bloweth, whither it listeth.' Its supply is uncontrolled, and difficult to direct. It is too uncertain a source of power to suit modern ideas of economy of effort.

But water is being increasingly used to give us energy. In India this is a source of wealth practically untouched as yet. The waterfalls in the Western Ghats supply Bombay and the area for miles around with electricity, and all the comforts it stands for. The Punjab is spending six crores of its capital to harness the waters of the Uhl river in the Kulu Valley. This scheme, known as the Mandi Hydro-electric Scheme, now completed, will in due course supply energy to many outlying districts of the Punjab, and bring 'light and sweetness' to many homes that do not know today any of the comforts of modern life. Life moves very leisurely, and at its old pace in these

hills. Electricity would give it speed : it would save much human time and trouble.

Another source of power is the untold wealth of coal that is used to generate steam. This source of wealth is limited; every nation is jealous of its coal, and uses it as economically as possible. The scarcity of coal in the world has led man to conserve a new source of power in petroleum, which is used to drive engines of the type that runs a motor car.

However the yet unexplored sources of energy are compressed air, and electricity, particularly the latter. Moreover physics has opened out before us a very vast field of research. Enquiry into the nature of electricity has led our men of science to believe that every atom of matter is a source of energy. Every atom contains many 'electrons'; each electron represents so much electrical energy. Some physicists think there is no such thing as matter; there is only energy. As yet, however, we do not know how to convert matter into energy. But our success with X-rays, and Gama rays, and other electrical phenomena justifies the hope that one day man will be in possession of inexhaustible stores of energy. He will not need coal and water to produce electricity; he will know how to convert all matter into electricity at will. Then he will have saved not only time and trouble, but also partially solved the mystery of creation.

## CHAPTER VII

### *The Invisible Enemy*

FROM the Witch doctors of Africa to the modern specialist in medicine the world has travelled a long way. Even now in many villages of India disease is believed to be caused by the anger of gods and goddesses. Not infrequently women take a sick child to the shrine of a god, offer worship there, and believe that they are helping to cure the child. A fond parent will take to a neighbouring *faqir* a present and request him for an amulet which, he believes, will cure the child of a chronic fever. The ordinary village *hakim* is merely a man who sells drugs. He knows nothing of the causes of disease, or of their cure. The ancient systems of medicine have been neglected, and the new Western methods not yet practised except in large towns. The result is a very high death-rate, terrible suffering due to ignorance, and general misery which results from a body weakened by the constant attack of one disease or another.

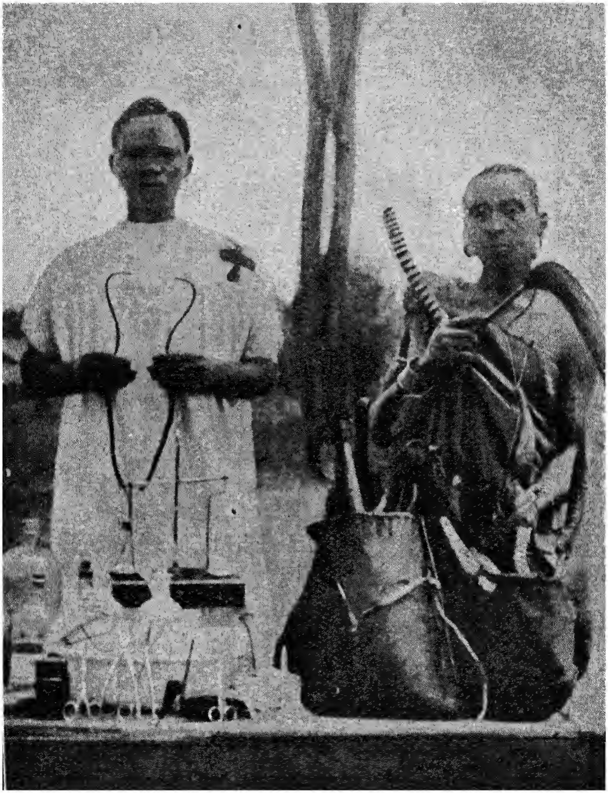
There is no excuse for us to suffer any longer. It is lack of education, and not lack of scientific knowledge in the world that causes our suffering. Four hundred years ago men did not know what the plague was: so terrible and sudden were its ravages that the only satisfactory explanation was to call it 'a visitation of the wrath of God.' The only possible

remedy was to fly away from it. Even in Europe where the Mohammadan physicians had carried a new system of medicine with them, disease was regarded for centuries as nothing but a natural punishment of our sins. When a more rational view of disease became accepted, doctors sought to cure disease by better sanitary conditions in our homes and streets. They did not know the causes of disease; they knew only its symptoms. They tried to cure it; they did not know how to prevent it. They were brave, kind-hearted men who devoted their lives to alleviate human suffering : they did not know how to prevent it.

Investigation into the causes of disease started with the discovery of bacteria by the French chemist, Pasteur. Before him some doctors had suspected that disease might be caused by the presence in the human system of poisonous germs, or the like. But as they could not explain how they came to be there, or how they were got rid off, their brother doctors laughed at them as if they were no better than the African Witch doctor who believes in ghosts and evil spirits that cause fever in an invisible, inexplicable manner. The discoveries of Pasteur and of men who took up his theory established beyond doubt that the more deadly diseases are all caused by bacteria, or germs.

Strangely, Louis Pasteur, was not a doctor, but only a chemist engaged on a research into the causes that turn beer sour. He was born in 1822 in a small French town where his father was a tanner. It was the great ambition of his father that young Louis

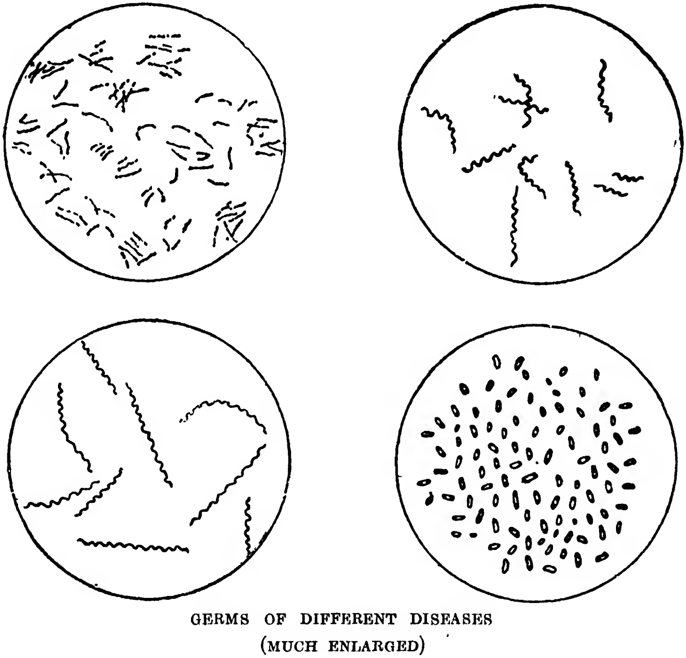
should become a Professor at one of the big colleges in Paris. This ambition of the poor tanner was ful-



AFRICAN DOCTORS
(On the left a modern doctor; on the right an old 'witch doctor')

filled in a manner hardly dreamed of by him; for Pasteur rose to be the most eminent Professor of

his day. He lived to the age of seventy-three but retained the same old vigour of his youth. 'Work, always work' was the ideal of his life. He founded the famous Pasteur Institute of France where treatment for rabies was first given. Now every civilised country of the world has a Pasteur Institute where



GERMS OF DIFFERENT DISEASES
(MUCH ENLARGED)

the treatment for rabies is given to save hundreds of men from the maddening pain of this fatal disease.

We owe to Pasteur the discovery of the microbes of rabies, and of cholera, but above all of the principle that disease is conveyed from one individual to

another by microbes. He tried his experiments on rabbits and guinea pigs and showed how the presence of germs caused disease in all living beings. It set the whole medical world talking, though very few people believed in it, or understood the full significance of Pasteur's discovery. It was really the first step towards the conquest of disease.

The next step was taken by a young English doctor, Lister. He was five years Pasteur's junior. When as a young house surgeon, Lister went into a London hospital he was appalled by the large number of deaths among those who had undergone an operation. Though the operations were generally successful in the sense that the affected part was properly treated under the knife, the wounds generally festered, the pus flowed freely and very few of those who had been to the surgeon's table ever survived. The average Indian has still the same old horror of operations, not knowing how safe modern surgery has become. The doctors themselves were in despair, because inspite of the best care and cleanliness they could not prevent the wounds from festering.

Young Lister believed from the first that some means could be found to put a stop to this large mortality and suffering. But except in maintaining greater cleanliness he made little progress till he heard of Pasteur's discovery of the bacteria that cause the fermentation of beer. That gave him the clue that he wanted. Now he realised that the germs that cause the festering of the wound could not grow in the wound; they must be carried there. At first he tried to exclude the air from the wounds. By

a series of experiments he was led to the conclusion that anything that touches a wound, from the surgeon's knife to the cotton thread that may be tied round it, is a source of trouble. Thus he laid the foundation of modern surgery in which everything is sterilized, that is, made free from germs. The only cure of a wound is to keep it free from germs. It is impossible to estimate the millions of lives, and untold misery that were saved by the simple discovery of Lister. All the miraculous cures performed by the surgeons today would have been impossible but for his devotion to the ideal he set before himself early in his career. At the close of the nineteenth century it was said that 'Listerism' had saved more lives than all the wars of the century had sacrificed.

Even when it became known that most diseases were caused by germs, it was not easy to find out the nature, the habits, and the carriers of these germs. For long it was not possible to trace the causes of malaria, because we could not find out how the germs of malaria were carried about. The late Sir Ronald Ross, formerly the Director of the Ross Institute for Tropical Diseases in London spent years of patient toil in India before he discovered the existence of Anopheles. This female mosquito sucks up the germs of malaria from a malarial patient; they breed in her blood in large numbers, and when next she stings other persons, she lodges these germs in their blood.

These researches are carried on with great sacrifice of men and money. Dr. Koch of Germany worked in his laboratories for fifty years to carry to a finish

the work started by Pasteur. He discovered the germ that causes consumption, and suggested a cure for it. He went to Egypt to study cholera; he came to this country to enquire into the causes of the plague; it was a Japanese pupil of his who discovered the germ that causes bubonic plague—the deadliest form of a deadly disease. Doctor Koch never spared himself any trouble so long as he could track down these enemies of mankind. He risked his own life and went to East Africa to find out all he could about the sleeping sickness that is caused by a fly-bite.

Once the causes of a disease become known, the doctors work till they can find means of preventing it. A new science, the science of bacteriology has grown up in recent times. It aims at the study of the bacteria, or germs, that cause disease. By finding out their habits, and the habits of insects, such as mosquitoes and flies, who carry them about, a bacteriologist puts us on our guard against the attack of these germs. He prepares vaccines which are injected into our bodies to prepare us against the disease. The principle of these vaccines is very simple. A vaccine is a liquid full of the germs of a disease. It is prepared by a bacteriologist, and the germs are artificially grown. A little of this vaccine is put in our blood every day by means of an injection. The blood fights against these germs; as the germs are very small in number, our pure blood can easily kill them. In this way our blood gradually becomes used to fighting these germs and acquires sufficient strength to fight against the disease when we are at-

tacked by it. Therefore in the days of an epidemic, we are advised to get inoculated against the disease. The doctors make us a little sick, so that we may not be very sick with the disease.

It will be clear from this account that men who first discovered this cure of disease, must have run a great risk. To find out what dose of a vaccine should be given, or whether an injection can be given at all, experiments must be performed. A man who submits to such an experiment runs the risk of death at any moment. But the service of humanity always calls forth many brave men who lay down their lives in the fight against disease. It is recorded that a large number of soldiers in the American army volunteered themselves for experiments on Yellow fever. For long the causes of this fever remained obscure. It was suspected that, like malaria, it was caused by a germ carried about by a mosquito. But which particular kind of mosquito carried the germ or how it grew, no one knew. In 1912, the Government of the U.S.A. appointed a medical commission under Dr. Reed and asked them to enquire into the causes of this disease.

The Commission asked for volunteers to risk their lives and submit to experiments. At the very first invitation several soldiers of the U.S.A. army came forward. A few were selected and all the arrangements for their departure with the Commission were complete. The general, as if to cheer up and encourage the soldiers, announced that handsome pensions will be paid to the survivors of those who died as the result of those experiments. The volunteers, one and

all, withdrew at once. 'We came forward to lay down our lives for the good of man, not for the love of money', they said. It was an insult to their manhood to offer them a reward as if they were mercenaries.

It is only with such sacrifices that the doctors of today have succeeded in controlling disease, and reducing pain. They have discovered means by which a man can be made unconscious so that he may be operated upon without risk or suffering. By means of a simple injection they can put into a healthy sleep a man yelling with the agony of pain. They can cut out a bone and graft another on to the remaining bit. They can give a man new lease of life. In fact they can do almost anything but create life. Such is the reward of the patient pursuit of truth.

## CHAPTER VIII

### *A Famineless World*

NO less remarkable than the conquest of pain is the modern attempt to conquer poverty. Persistent efforts are being made by nations to bring about a new social system in which all men will be provided at least the bare necessities of life; so that in a century or so there should be no poor men in the world. Old prejudices and customs, no doubt, take time to disappear; but it is recognized by every civilised government today that every citizen has a right to be comfortable. It is estimated that in the eighteenth century eighty per cent of the people in England were poor; that is to say they had no certain means of livelihood, could not afford two meals a day, or clothe themselves properly. Today the number of such people is very small: and even that small number is looked after by the State. Even in India poverty is on the decrease; and its worst form which resulted from famine, has been entirely rooted out. Famines are no longer possible in India. There are canals to guard against uncertain rainfall. The means of transport have been developed to carry foodstuffs from one area to another when the crops fail. The Government of India have a special reserve fund to be used in times of famine or the like.

Thus the old horrors of famine in India are luckily

no longer possible. It is inconceivable that men should in future sell their children, or throw them on the roadside to escape the pangs of hunger themselves. However famine-stricken an area, provision has to be made to protect the population against such extreme forms of starvation as forced them to live on dung, on roots of trees, or even dry grass. These things have been known to happen, but are no longer possible. It is the business of every modern State to protect its citizens against such distress.

Nations are fighting against poverty by increased production. A scientific study of soils is undertaken to find out how they can be made to yield richer crops. Manures made of chemicals are put into the fields to raise bumper crops. It is estimated that in the sixteenth century an acre of land in England produced only six bushels of wheat a year. Under scientific cultivation it yields more than thirty. In India there is a particular prejudice against scientific agriculture. But in countries where it has been tried, millions have been added to the annual income of the nation.

This department of science has received most attention in Canada and the United States. Chemistry, physics, botany, zoology, and bacteriology have all been put under contribution to change the nature of plants, and to increase their yield. Strange as it may seem, it is possible to develop any particular quality of a fruit, and to suppress its undesirable features. By scientific cultivation, the orange can be made sweet, without pips, and full of juice.

The man who has been most successful in changing and altering plants is Mr. Luther Burbank, an American plant breeder. He was born in 1849, and early devoted himself to the better cultivation of his father's farm. When he died in 1926, he had the satisfaction of having created several new varieties of vegetable and fruit. He studied the life of plants in his vegetable garden with the same affection and care with which we study the comfort of our friends. On one of his potato plants, one day he found a new kind of seed. These he preserved and planted very carefully. From the seeds grew twenty-three healthy plants, from each of which grew a different kind of potato. One of the plants was specially strong, and from this was taken a large cluster of potatoes which were unusually large and smooth, and of a very fine quality. The potatoes were sold for seed which proved to be so good that the gardener who bought them called them the Burbank potato. This improvement in the size and quality of the potato resulted in the addition of millions of pounds to the wealth of the United States of America.

This is only one example of the many developments effected in the breeds of plants and animals. By the study of well-known laws breeders get rid of specimens with undesirable qualities, and breed future varieties from those specimens only that are good and desirable.

More food and better hygiene have added to the comfort and happiness of mankind. Still there are men in every country who cannot get enough work to do. The number of unemployed is on the increase.

An unending fight is continued against this evil, and every country tries to find new fields of work for its citizens. If no work can be found, the State gives every man out of employment a small weekly allowance to provide him with food, and a roof over his head. He continues to get this 'unemployment dole', as it is called, till work is found for him. Officers exist in every large town where records are kept of vacancies as well as of the unemployed. Both those who want workers, and those who want work go to these offices and get information. In this way the whole system of unemployment is organised in every Western country.

Laws have been made to ensure that every worker will be well looked after by his employer. Good sanitary houses are provided. The factories in which men are asked to work are well-ventilated. The hours of work are fixed according to the nature of work : the harder the work the smaller the number of hours per week which a man is asked to put in for a full weekly wage. For those who work in dangerous occupations, such as coal mines, special provision is made. All employers have to insure their men against death, or injury through accidents. The State insures them against old age. When they are old or crippled, the State looks after them.

Every nation wages a war against ignorance : because ignorance means poverty. Therefore all boys and girls must go to school till they are fourteen years of age. This education fits them out for life. They learn to use their eyes and hands well : to earn their living, and be useful citizens. They are taught

to be healthy and responsible members of the community. Laws of hygiene, and the duties of citizenship form a special feature of this free and compulsory education. If he is taught what are his rights, he is also told what are his responsibilities as a citizen.

If this war against ignorance and poverty continues in every country, before long every man will have his proper share of the wealth and happiness of life. If he suffers then, it will be through his own folly.

# CHAPTER IX

## *The Machine Age*

WHEN Morse, an American painter, became interested in telegraphy, and after an uphill fight obtained a grant of thirty thousand dollars from the Senate, he did not know that one day telegraph wires would encircle the whole earth. Like most other inventors, Morse passed his days in extreme poverty before he could convince the world that he had initiated one of the easiest means of communication from one end of the earth to the other. But it must not be imagined that telegraph wires that carry the feeble current of electricity over land, and work the telegraph instruments, are also the means by which messages are carried across the sea. The distances across the water from country to country are great. It is difficult to insulate the wires submerged under the water. There are no supports to keep these wires in position.

Because of these difficulties submarine telegraphy came into existence long after the use of telegrams on land. The one man who more than another made submarine telegraphy possible was Lord Kelvin. He was a son of Professor Thomson of the Glasgow University. He went up to Cambridge at the age of seventeen and distinguished himself there as a mathematician of great note. He was not without other interests, however. He was a great athlete, and loved literature and art. At the age of twenty-three he was appointed to a professorship in science at the Glasgow University where he started his experiments in electricity. From the very beginning he devoted

himself to the practical application of his researches. All his life he worked out problems of the most difficult character, as to the strength, action, and effects of electric currents under all sorts of conditions.

The first long-distance cable was laid across the Atlantic Ocean between Ireland and Greenland. There had been previous attempts more or less successful at telegraphic communication between England and France. But they had been successful enough only to convince the critics of submarine telegraphy. Many attempts had been made by Bright in England, and Field in America to connect the two countries. Hundreds of tons of cable were sunk in the ocean during 1857 and 1865, as through one reason or another the cable snapped in mid-ocean. At last in 1865 a cable was successfully laid and worked well for two months after which the messages became too feeble to be registered. The fact was that the strength of the electric current carrying the message was reduced in travelling along the cable owing to the thickness of the wire, the distance, and the action of salt water on the insulating material. Lord Kelvin studied these aspects of the question and built not only a better cable but also a very delicate receiving instrument sensitive even to very feeble electric currents.

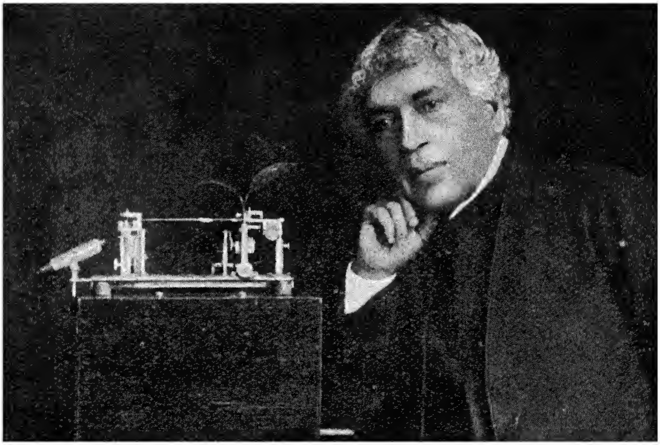
As a result of his efforts the whole world is now encircled by wires. Three lakhs of miles of cable have been laid under water. Cables run under the Atlantic and Pacific Oceans, the North Sea, the English Channel, the Black and Mediterranean Seas, the Indian Ocean and all Far Eastern Waters.

Millions of words per day are sent between one end of the earth and the other. The cost of sending these messages runs into thousands of pounds, as a cable is very expensive to make, and very expensive to lay. The electric current carrying a message passes through a very thin wire, the thinner the better for the strength of the current. But this thin wire would snap like cotton thread if it were not protected by coats after coats of rubber, coal-tar, hemp, lead, or brass, and even steel. A cable is thickest near the shore, and grows gradually thinner in mid-ocean. The cable rests at the bottom of the ocean, and the engineers experience great difficulty in raising it for occasional inspection. For, in addition to its own weight the cable gathers weight from the many sea plants and sea animals that fasten and grow upon it at the bottom of the sea. Sometimes a cable is pulled to the surface with a large piece of coral growing all round it, or some big fish is drawn up with it. Some years ago something went wrong with a cable near Valparaiso, in South America. When it was hauled to the surface, there was a dead whale with the cable coiled round its body. These are only some of the difficulties that the early layers of deep-sea cables had to face, and learn to overcome.

But man is ever busy not only to overcome difficulties but avoid them if possible. The invention of the Wireless, and its development in recent years dispenses with most of the difficulty and expense of laying cables through the sea. Lately we have learned that wires are not necessary, but that the electric current or whatever else it is that runs through

wires will run equally well through space without any wires at all. Every day now electric currents are being sent without wires over long distances—from England to India, for example. What is it, then, that runs or moves along the wires, or through the air?

It is exactly like light—*a wave in the ether*. It is not carried along by the air : the air cannot move even a thousandth time as fast. It is conveyed by the ether which is everywhere, though we cannot see it.



SIR JAGADIS CHUNDER BOSE

The only difference between electric waves and light waves is that of wave length : the electric waves are bigger. Otherwise they are exactly of the same kind, move through the same ether, at the same speed, and they follow exactly the same laws in all respects.

One of the first in the field to discover the

existence of these waves was the Indian scientist Sir Jagadis Chunder Bose. But with characteristic indifference to the commercial side of scientific questions Sir Jagadis left it to others to develop his ideas. Another scientist, Professor Hertz of Germany, worked independently on very much the same problem. Marconi, the young Italian inventor who first surprised Europe by wireless telegraphy was really working on the apparatus constructed by Hertz, and perfected by Professor Branly, a French physicist. Only the worker in a laboratory looks more to the pursuit of knowledge. Its application to increase the production of wealth is not generally his concern.

In recent years radio telegraphy—as wireless has come to be called—has made very rapid strides. It has proved its usefulness by saving thousands of lives on sea. Every modern ship is equipped with a wireless set. It can flash messages all round in distress. These messages ride the waves of ether in all directions, and are received by other ships or wireless stations in the vicinity of the ship in distress. Help can thus be rendered even at night, or in a storm.

It has added also to the world's capacity for enjoyment. The music played in a theatre hall in Bombay may be listened in at Lahore. With a powerful-enough radio set which would not cost more than five hundred rupees you may get in touch with London. The markets of the world have been linked together by wireless; the quotations from New York to London are repeated in a few seconds. The radio has opened up immense possibilities. Wireless telephony is already an accomplished fact. In a few years more

you will be able to talk to your friend who is receiving his education at an English University. The man of science assures you that you will not only hear his voice but be able to see his face as well; for he has tried experiments in television and succeeded. He can send a picture across the ether and reproduce a photograph hundreds of miles away. These are not mere toys with which scientists amuse themselves: they are achievements that open up new vistas for mankind in the future.

There is hardly a child who has not heard the gramophone and been delighted by the mystery that surrounds it. A talking-machine was first made by Edison, the great American inventor, in 1877. Since then many improvements have been made, and it is possible to buy today a machine that talks like men—so faithful is its reproduction of sound. The principle on which a talking-machine works is quite simple. First the sound waves of speech are recorded on a wax-like disc. This is called the 'master-record'. It is then put through an electro-plating process whereby a permanent impression of it is secured. This is used to procure a die or stamp from which the gramophone records that are sold to the public are stamped or pressed. These records are made of vulcanite; their manufacture is quite easy: that is why they are comparatively cheap.

A very interesting application of the talking-machine is the dictaphone. It is a combination of the recording and reproducing machines put together for the use of business men. It works like a gramophone but instead of the 'record' it takes a wax-cylinder

The wax-cylinder is put on, and the machine is started. The business man who is using the machine talks into the mouthpiece of a tube. As he talks the sound waves of his speech are registered on the revolving wax-cylinder : they are reproduced on the wax surface

A MAN SPEAKING INTO A DICTAPHONE
*(By permission of the Dictaphone Co. Ltd.)*

in the form of a thin wavy line. The cylinder will hold the impression of perhaps a dozen letters before it is full. When the man has finished speaking his letters, he stops the machine.

Then comes his typist. When the typist is ready to write the letters, he sits near the machine, puts two little receivers to his ears, pushes a little lever and starts the machine. The wax-cylinder begins to unroll the speech of the master. The typist can move

the cylinder fast or slow according to his own speed on the type-writing machine. These machines are very useful in large business offices. The typist may be busy, or have gone out for a time when his employer wishes to dictate, or the master may think of a letter when the office is closed and every one has gone home. He can talk his letters into a dictaphone, giving full directions, and even spelling out difficult or strange words, and the typist can write them out on his return. When a wax-cylinder has been filled, and the letters have been written, a thin film of wax is shaved off with the keen edge of a knife. A cylinder lasts generally a hundred 'shaves', when a new one can be bought and the old one replaced.

Another very interesting application of speech reproduction is the newly established talking-picture. The cinema has become quite as familiar as the gramophone. A moving picture no longer strikes wonder or terror in the heart of a veriest rustic. But the picture that moves and talks at the same time is still in its infancy. So great is its success already that it is bound to develop. The time is not distant when a man's voice will be reproduced together with his movements and gestures with equal faithfulness. Men will see and hear a play performed in London years ago as if it was being staged now in their presence. A permanent and true record of their performance will be kept and reproduced at will.

The child of the future will indeed have other toys to amuse him—toys in which the best efforts of man to conquer nature are reflected. The inventions and achievements that excite our wonder will leave him cold.

# CHAPTER X

## *Mere Man*

IN speaking of man's achievement on the earth, it was natural that we should have adopted a note of pride, almost of boasting. The ways in which man has shown his powers and intelligence are, as we have seen, many and fascinating. But it would give you a very wrong notion of the place that man really occupies in creation if we did not speak of the relation of man's world to other worlds. It is then that we feel the truth of what poets and philosophers tell us. Kant, a German philosopher of the last century, could never look at the sky, he said, without being very forcibly struck by the contrast between man and universe; the insignificance of man and the immensity of a universe no *human* power can comprehend. And the English poet, Tennyson, said in a similar mood how he regarded man as 'an infant crying in the night, an infant crying for the light'.

The void or empty space in which our earth moves is like an ocean of nothingness that in all probability has neither a beginning nor an end. It is a shoreless sea of ether which is not visible to the eye. This space has no beginning and no end. It has no colour; the blue colour of the sky is due to particles of dust in the atmosphere of the earth. The atmosphere extends only three hundred miles; in the vast beyond there is no colour; only a darkness so thick

that you could almost cut it with a knife: 'the palpable obscure' as one poet put it.

In this space move about in their paths millions upon millions of balls of fire, and groups of shining things. You all know them: you see them at night. We lose all idea of numbers and distance once we get away from the earth and begin to move about in the pathless heavens. In order to grasp clearly what *our* universe consists of, it would be best to think of its two parts separately. First there is the small colony of which our earth is a member. This consists of the sun that gives us light and heat; the various other planets such as Mercury, Venus and Mars; and the moons that attend on the various planets. Occasionally we have visitors to this colony from other parts of our universe: they are the comets that come and go carrying a shining tail with them.

Then there are the other heavenly bodies which together with our solar system compose our universe. The other heavenly bodies which appear to us as stars at night are also suns very much like our own sun. Our sun is a star; the stars are suns. Perhaps these suns have solar systems—planets and moons of their own. We don't know, yet; the distance is so great that we cannot see much even with our powerful telescopes. The nearest star, Alpha Centauri, is twenty-five billion miles away. The ray of light that reaches us from this star today left the star more than four years ago: and this is the nearest to us of the stars of our universe. It is rightly believed that there are some stars so far away from us that their light has not reached us yet. There are altogether about two

to three million stars, or suns, in our universe. Our sun is more or less in the central region of this uni-

A STAR CLUSTER

verse—only a few hundred billion miles from the actual centre.

All these stars, like our sun, are masses of flaming matter radiating immeasurable quantities of heat and light. Our sun is a star of very modest dimensions: there is, for example, the star called Antares in the constellation Scorpion, the diameter of which is about 300 million miles. That means that Antares has 40 million times more bulk than the sun. Do you want to know how much heat Antares is radiating? We shall give you some idea of the heat of our own sun which is comparatively so much smaller, and then leave you to calculate the heat of Antares. So great is the intensity of the heat pouring outward from the sun, that if we could build up a solid column of ice from the earth to the sun, nearly two miles and a half in diameter across the dark space of ninety-three million miles that separates us from it, and if then the heat of the sun should fall on it in full, it would dissolve and melt, not in an hour, or a minute, but in a single second. One tick of your watch and this inconceivably huge mass of solid ice would be water; seven ticks more and it would disappear into space as steam.

Of course all the suns do not give forth the same volume of heat. Their heat depends not only on their mass, but also on their age. For there are among the stars also boys and girls, young men and women, and middle-aged people like our sun, and old people nearing their grave. Our astronomers know the age of a star from the colour of its light. A star that gives a dull red light is either very young, or very old. It means that it has either not acquired sufficient heat, or it has lost all its youthful energy. If it is

still young they call him a giant; if it is old it is a mere dwarf. A star in the prime of its youth is bluish-white. As it declines in age it becomes yellow like our sun, and then orange, and then red, and then dark and invisible. But how long it takes a sun to die we cannot say. We cannot say this for certain even about our own sun about which we know so much. It is impossible to express an opinion about other suns so far away.

We have again and again spoken of *our* universe; because it is not only possible but very probable that beyond our universe there are other universes. To get an idea of what it sounds like, suppose you had a friend living in Antares in Scorpion and he wished to send you a wireless message on the waves of the ether, how should he address his marconigram. Something like this :—

John Brown,
39 Paternoster Row,
London E.C. 4,
England,
The Earth,
The Solar System of Sol.,
Via x, y, z.

This would be a brief way of addressing the message to you.

Does this mean that the other solar systems and their planets have life? Are there in other parts of the universe beings like ourselves? It is pleasing to think there are, but it is difficult to find any proof in support of this fancy. Some astronomers in the past toyed with the idea that our sun and all its

planets had life. But recent investigations with the very much improved instruments of today have revealed a different story. It is inconceivable that any form of life should be possible in the sun itself. You have formed some idea of its heat already. It is possible that some of the planets may be inhabited—but which are they? Neptune, Saturn, Jupiter cannot possibly be inhabited: they are too far away from the life-giving rays of the sun to support any form of life. From what we know of conditions of life on earth, it is not probable that any form of life should have arisen, or been maintained on these planets.

There are left Mercury, Venus, and Mars. So far as Mercury is concerned the question is easily settled. It cannot possibly be inhabited for two reasons among many others. First, it keeps one of its sides perpetually towards the sun; so that one half of this planet is boiling hot eternally, and the other half always has the freezing cold of space. Such extremes of temperature render the likelihood of any form of life very remote. Secondly, Mercury has no atmosphere, or if it has any, it is too thin to support life. As in the case of the Moon, the atmosphere of Mercury has disappeared into space. Besides, Mercury is very much smaller than the Earth, and the weight of things there is only one-fourth of what it is here. A fat man weighing four maunds, and able to walk on the earth with some difficulty would run about on Mercury like a child, because his weight would only be a maund.

The next planet to be considered from this point of view is Venus, the most beautiful of the 'stars' that

are visible: it is the famous 'Evening' and 'Morning Star'—though all its light is a reflected glory. Much about the surface conditions of Venus cannot yet be known because it is always screened from us by a thick mass of clouds. Its atmosphere is very rich in moisture. That in itself is no argument against the existence of life on Venus: life can maintain itself in very adverse conditions. The wet atmosphere and diffused light of Venus are, perhaps, congenial to some form of creature we have no experience of on this earth. Besides the planet is very nearly the same size as ours; is neither too near nor too far from the sun. For years it was supposed that Venus, like Mercury, always kept the same side to the sun. Recent observations have shown that Venus revolves round its axis; though the period for a complete revolution is much more than an earthly day: more than five or six weeks. So that the inhabitants of Venus, if there are any, have a 'day' and a 'night' that last about forty times as long as our day and night.

The only planet about which there is a reasonable possibility of the existence of life is Mars. It has pleased astronomers to play with the idea that Mars is inhabited. Attempts have even been made to get in touch with the Martians. But in the present state of human knowledge, there are no means by which a message can be sent beyond a few miles of our atmosphere. Other considerations, such as those of size, temperature, atmospheric conditions, and above all observation of the surface of Mars, lead some astronomers to believe that Mars is, perhaps, inhabited. Its surface shows very regular lines which are sup

posed to be 'canals' through which the Martians convey the waters of their frozen regions to warmer climates. It has seasons, and day and night, very much like our own—only a little colder as on our mountain tops where the atmosphere is rare.

Dr. Lowell, the greatest of the students of Mars, came to the conclusion that Mars is much further along in its planetary career than is our Earth. The Martians are more advanced in their intelligence, their resourcefulness much greater. Their planet is an alternation of Sahara, and small snow-clad regions near its poles. It would be uninhabitable were it not for the wonderful canal system, designed, it would seem, by very intelligent beings in desperation at the fate which confronts them, and urged on to gigantic efforts to save themselves from complete destruction.

Whether there are any inhabitants in Mars or not, it does not very much matter. Most astronomers today incline to the belief that there are not. But man at least exists; only to prove his own supreme insignificance. What a strange fancy! What if in this vast immeasurable universe man is the only creature endowed with intelligence, his the only world with life! What strange desolation and loneliness in a Creation that has practically neither a beginning nor an end! And conversely if he is one of many other races of intelligent beings in other spheres, again how strange that he should know nothing about them, and be for ever cut off from them! A pigmy, a mere drop in the ocean of life, a being with a mysterious beginning, and an unknown end!

## CHAPTER XI

### *Trailing Clouds of Glory*

NATURE guards her secrets very jealously. After centuries of toil and skilful discovery man knows but a very small fraction of what there is to know. After centuries of attempts to master the forces of Nature, they are not yet tamed or harnessed. Her power to destroy the handiwork of man still remains supreme. She has her volcanoes still : they send forth their lavas to burn his cities fiercely now as they did two centuries ago. The earthquake, inspite of the invention of the seismograph that registers the slightest tremor of the earth, remains even today a force before which man flies away in fear.

Not only these and many other forces of destruction in Nature remain the same, but also the enemies of mankind multiply fast. So fast do they seem to multiply that according to an English writer they threaten to destroy mankind. Microbes, the most insidious of man's foes, are ever on the increase. It is a fight to a finish : the microbe multiplying at a million a minute perhaps, and man learning to control and kill it. Whether or not H. G. Well's prophecy will come true, and insects rule this world a million years from today, it is true that man cannot afford to be indifferent. He cannot lay down his weapons and survive. He has been a fighter and must remain a fighter.

For Nature is yet unconquered. She has yielded up insignificant tracts of knowledge here and there, and man takes pride in his conquest as if that was all. But her major domain still remains unconquered, and the true man of science knows it. She has her mysteries to which a solution must be found only by very patient and unceasing labour. The origin of life is still a mystery. So are creation, and the future of the universe itself. Man does not know enough about himself yet : his own mind is, perhaps, the greatest mystery of all.

But man has shown by his achievement that he has in himself the seeds of his final triumph. Every day he adds to his knowledge, his capacity, and above all to his determination to continue the fight. An expedition like the Mount Everest Expedition shows how man pierces into the unknown by inches as it were. Since 1922, almost every year an expedition has gone forward into the Himalayas to gain the peak. There in the distance stands the lonely majestic peak uninviting, and formidable. Its approaches are guarded not only by altitudes where oxygen is rare and man can with difficulty breathe, but it is surrounded also by glaciers, and steep perpendicular hills, by cold winds and snow.

Man knows all this, and yet remains unshaken in his resolve to gain the peak. Every year he pushes forward. From 22,000 feet to 24,000 feet; from 24,000 feet to 27,000 feet—till 1927, when Mallory almost reached the peak, perhaps. He did not survive to return and tell us. One day when those heights are scaled by a hero among men, the bones

of Mallory will, perhaps, be there to make him only the second best. You might well ask what is the use of such expeditions, of the enormous expenditure of money on such useless attempts that lead nowhere. Nothing is achieved. How does the world profit by it?

The achievement is the gain in man's resolve to know the unknown. As Sir Francis Younghusband put it very well, 'Everest cannot add to her height; but the spirit of man heightens under every repulse'. It is this gradual heightening of the spirit of man that has made him what he is: the only controlling mind on earth. If he had been discouraged by failure, if he had given up trying after his first attempt to solve the problem that puzzled him had failed, he would have remained at a level of intelligence below that of the dog. His defeats are the only guarantee of his ultimate triumph.

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